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## TABLE OF CONTENTS.


LEADING ARTICLES: Page.

Hydraulic Excavation and Dam Building at the Croton and Lyons Dams in Michigan (illustrated); W. G. Fargo ..... 429

New Methods for Closing a Crevasse in a Mississippi River Levee: The Live Oak Crevasse, Louisiana (illustrated); M. W. Mount ..... 431

The International Congress for Hygiene and Demography. By a Special Correspondent ..... 433

A Note on the Effect of the Time Element in Loading Reinforced Concrete Beams (illustrated); W. K. Hatt ..... 438

Convention of the American Street and Interurban Railway Association ..... 440

Annual Convention of the American Boiler Manufacturers' Association ..... 444

The Survey of the Madeira and Mamore R. R. in Brazil (illustrated); E. H. Liebel ..... 449

EDITORIAL ..... Page. 445

The Longest American Railway Tunnel—The International Congress of Hygiene and Demography—The State of Engineering Knowledge on Column Design—Shipping Cement Clinker in Bulk for the Panama Canal.
Engineering and the Commercial View ..... 445

LETTERS TO THE EDITOR ..... 447

Practical Experience Wanted in the Use of Lime Mortar in Place of Cement; A. M. Shaw—The Strength of Hooped Concrete Columns; H. C. Burroughs—Two Questions of Column Design: The Design of Compression Members for Large Bridges and Butt Joints in Columns of Buildings (illustrated); T. Kennard Thomson—The Quebec Bridge; a Counterpart of the Forth Bridge Suggested; "Old Canadian Subscriber"—Fog Signaling on English Railways; "Railway"—Can Concrete Be Made Watertight? E. W. D. Knight—Notes and Queries.

ENGINEERING NEWS OF THE WEEK ..... 451

PERSONALS ..... 452

ENGINEERING SOCIETIES ..... 452


## HYDRAULIC EXCAVATION AND DAM BUILDING AT THE CROTON AND LYONS DAMS IN MICHIGAN.*

By WM. G. FARGO.†

The plant, to be described, was used for the following purposes: 1. Making highway cut and embankment. 2. Closing of the river and turning its course on the completion of the dam. 3. Making an embankment about 250 ft. long on the base and 55 ft. in height, the total width of the base being about 900 ft.

The Croton Dam, belonging to the Grand Rapids-Muskegon Power Co., and located on the Muskegon River, has a 40-ft. head and develops 14,400 HP. The dam of the Commonwealth Power Co., located on the Grand River, at Lyons, Mich., has 26 ft. head and developed 5,000 HP.

*Articles on the concrete mixing plants, steel sheet piling and other work in connection with water power dams on the Muskegon River were published in our issues of May 31, 1906, and April 4, 1907.

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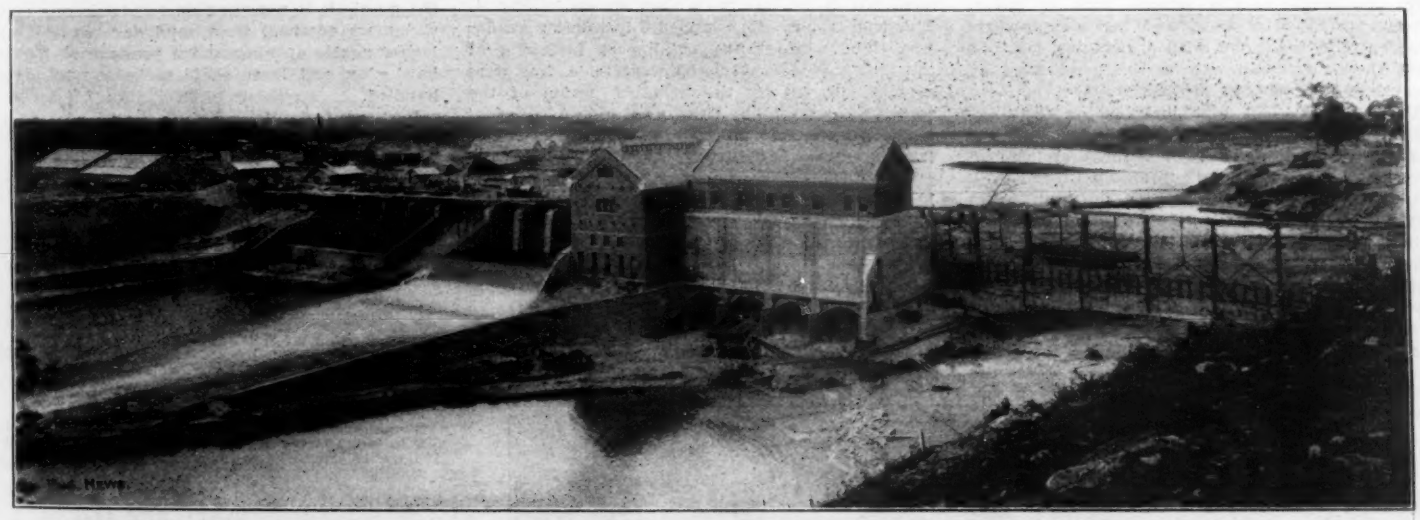

GENERAL VIEW OF POWER PLANT AT CROTON DAM, TAKEN SOON AFTER SLUICING BEGAN, AND SHOWING BOULDER SCREEN AT LOWER SIDE OF FILL.

In the process of constructing the dams described, the river was allowed to run in its original course, at one side of the work, and the closure was effected by narrowing the channel by cribs on either side. The final closure of the intervening opening was effected with one or more cribs swung to position and filled with stone. The sluicing plant was then set at work and a low fill, of long slope, under water, was made upstream from the crib. The sluicing troughs were then diverted to the downstream side of the crib and the permanent embankment put in place. The river, in the meantime, was turned through temporary openings left through the masonry of the dam. Such temporary closing cribs, when faced with a sluiced fill on the upstream side, were made almost entirely tight under a head of 15 ft. of water. The water seeping through and accumulating between the temporary and permanent embankments was all taken care of by a 4-in. centrifugal pump, running at intervals. This illustrates the possibility of making tight earth embankments when material is deposited in water and by the action of water. In Fig. 1 the trestle and hydraulic fill in the foreground cross the original channel of the river, the flow being diverted through openings in the dam beyond the power house. Two of the sluicing troughs are shown, running to opposite sides of the trestle. Figs. 2 and 3 are views from below, and shows the brush work and boulders put in to check the flow and cause the material to settle.

While the value of a sluicing plant lies in the cheapness of operation, it is also valuable as a means of moving material from a high level to a low level, where it would be very expensive to handle teams on the steep return grade. Another satisfactory use for such a plant is for depositing material in water, as in filling a pool or river bed.

### HIGHWAY WORK.

The first mentioned sluicing job required about 20,000 cu. yds. of fill, all of which was taken from the excavation required in connection with this same highway, which was an approach to the bridge just below the Croton Dam. The grade descended 15% toward the river and formed, for most of the distance, a side-hill cut, with the material deposited 40 to 50 ft. below, and from 100 to 500 ft. distant. For this work there was installed one 3-in. Gou'd rotary fire pump, costing about $200. It was driven by a 30 HP. motor and was set up on the river bank, a 3-in. pipe line being run up the bluff. The pump and pipe line were set up in two days by two men.

Between Nov. 15 and 20, 1906, four men with this outfit moved 3,000 cu. yds. of material out of the cut, and put it into the highway embankment for the bridge approach. The labor cost was $42 (four men 40 hours at 20 cts. and one man at 25 cts.). This is 1.4 cts. per yd. for labor. No exact cost was kept of the remainder of the work on this highway fill. The trough for handling the material was of iron, 20-ins. wide, with 5-in. vertical sides, and was laid on the ground as the work progressed upward on the 15% grade. The material was held to the slopes of the embankment below by means of brush, poles and straw. Only one 3-in. hose, with 1¼-in. nozzle, was used on this work. The material handled was all yellow sand.

### PRINCIPAL FILL AT THE CROTON DAM.

The principal fill made with the sluicing plant at Croton Dam comprised 104,000 cu. yds. of sand and gravel. This material was taken from the bluff and hill immediately adjoining the end of the embankment into which it was put. The total height of the hill above the top of the finished embankment was 75 ft. On account of the grades required for the troughs the actual face against which the nozzle worked did not exceed 40 ft., and for the most part it was about 30 ft. The greatest distance which material was moved in the troughs was 800 ft. The grades were generally 8 and 9%, but on some of the longer troughs the grade was reduced to 5 and 6%, toward the end. With grades less than about 6 or 7% there was always trouble caused by stoppages in the troughs, requiring one man to about every 50 ft. of trough to prevent them. The yellow sand, common to all of the pine country of northern Michigan, will run readily on itself, when wet, at about 10 or 12% grade, that is when forced along by the action of water running down the slope. The nozzles were not used for forcing material along the troughs or channels, except when the channels became clogged. The nozzles were usually worked in pairs, concentrating their forces at the base of the bluff,

Where the base of the excavation was clay, or hardpan, no special headworks were necessary to divert the water to the troughs, but in sand and gravelly soil it was necessary to have a converging box, or series of boards set up in V form, to start the water into the trough.

PUMPING PLANT.—The installation of pumps used for this sluicing plant was not the most efficient or desirable, but was used because these pumps were on hand and readily adapted for use with the motor equipment available. On future work either a direct-connected turbine pump, or some other efficient pump, not subject to frequent breakdowns will be used. The pumping plant consisted entirely of underwriters' rotary fire pumps belted to motors. There were four 6-in. pumps, one 5-in. and two 3-in. Two of the 6-in. were Rumsey pumps; the others were Goulds pumps.

The pump shed, about 20 × 24 ft., was built on the river bank and projecting over the water, so that the pump suctions could be dropped down directly below the pumps. Rotary pumps do not operate well with a suction longer than 8 to 10 ft. The four pumps were set in line close together and connected into a 10-in. header, with the motors at the opposite, or land side of the building.

The 6-in. pumps are designed to run at from 200 to 250 r. p. m.; at the higher speed they should give about 100 lbs. pressure at the pump and 1,125 gals. per minute each. In order to run them at this capacity and pressure, assuming their efficiency at 50%, there is required 140 HP. While rotary pumps give good satisfaction for intermittent service of short duration, as for fire purposes, they are not adapted for continuous hard service, as on a sluicing plant, and out of the seven pumps on hand fully half were out of order and undergoing repairs the greater part of the time. The injuries were to the gears and cams. In making the first fill above the closing crib, one of the smaller pumps, with its motor, was mounted on a scow, and had the pressure pipe on land connected with a swinging joint, so that the scow could rise as the pond filled by closure of the openings in the crib.

PIPE LINE.—The pipe line leading from the pumps was a 10-in. spiral riveted pipe, and had gate valves located between each pump connection and beyond the last pump. This force main was extended along the face of the bluff about 1,000 ft., being successively reduced to 8-in. and 6-in. by wrought pipe with screwed connections. There were tees, with 4-in. outlets, placed at convenient intervals for laterals and hose connections; 4-in. iron-body gate valves were placed at these tees. The sluicing work was commenced at the far end of the pipe line, where the first closure of the river was to be effected and where the bluff was the lowest, and the length of the force main was reduced as the work progressed.

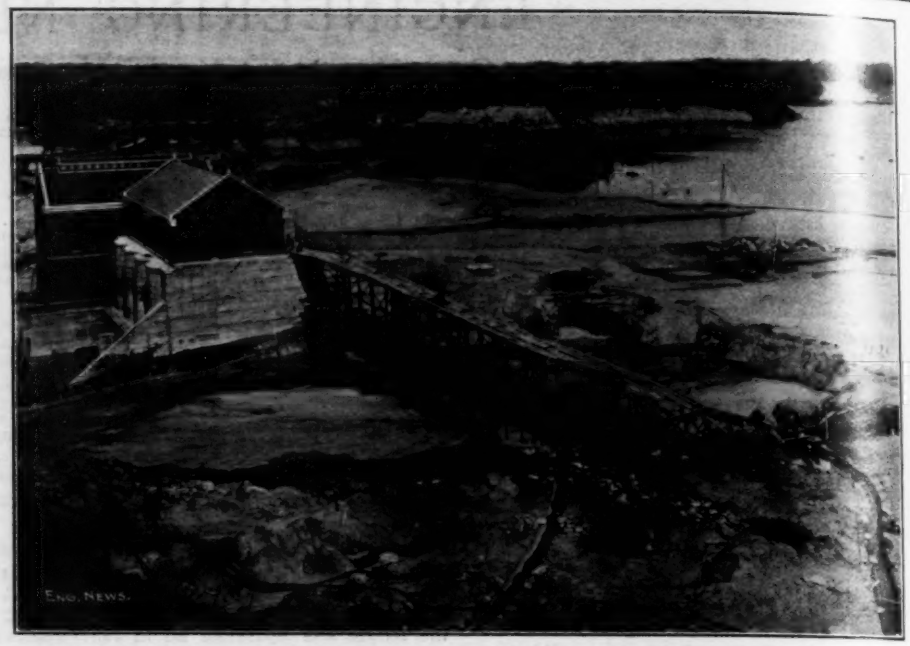


FIG. 2. CROTON DAM AND POWER-HOUSE ON THE MUSKEGON RIVER IN NEWAYGO COUNTY, MICHIGAN.

(The original channel is being closed by the hydraulic fill against the end of the power-house. The temporary channel shown connects with temporary openings in the concrete dam beyond the power-house.)

TROUGHS.—The troughs were for the most part made of No. 12 black iron, of 30-in. semi-circular section, 10 ft. long. They cost 2¾ cts. per lb. (including the bending), or 49½ cts. per lin. ft. of trough. There was used on the Croton work 850 ft. of this troughing, shown in Fig. 4. This iron trough when lapped 6 ins. on 8% grades was tight without any calking or fastening at the joint. Wooden troughs were tried, but were rapidly cut out by the grinding action of the material carried by the water. After four months' constant use, on two jobs, the iron troughs show but little wear.

NOZZLES.—The nozzles used were mostly 4-in. hose, tapering in 24 ins. to an opening of 1¼ or 1½ ins. The taper was uniform and the nozzle end machined and polished smooth for about 2 ins. inside from the tip. Each nozzle was clamped to a 2 × 10-in. plank, about 12 ft. long, and this plank pivoted to a standard similar to the jack used by a wagon-wheel painter, only heavier. This simple device, Fig. 5, served the purpose of the more heavily constructed monitor or "giant" used for high pressure and larger pipes and nozzles. With this arrangement one man handled each nozzle, and was assigned one helper for moving hose and keeping the troughs in shape near the nozzle. Where the grades were sufficient no other men were required in the pit. With such an outfit and a pressure of 60 to 80 lbs. at the nozzle it is not possible to handle any material more compact than sand and gravel. With larger nozzle opening and a pressure of 150 lbs., hard clay and loose shale rock may be readily handled.

In two of the jobs described, the base of the work was a hard and pure clay, in which the movement of the water would cut a slight chan-

FIG. 3. FACE OF HYDRAULIC FILL, SHOWING BOARDS, STRAW AND CRIB-WORK TO CHECK THE FLOW.

COST OF SLUICING AT CROTON DAM.

| | |
|---|---|
| 2 6-in. Rumsey underwriters' rotary fire pumps (new) | $840.00 |
| 2 6-in. Goulds underwriters' rotary fire pumps (second hand) | 750.00 |
| 430 ft. 10-in. No. 16 gage spiral riveted pipe, cost 60 cts. per ft. when new; second hand, 45 cts. | 193.50 |
| 400 ft. 8-in. wrought pipe and fittings (new) | 436.45 |
| 414 ft. 6-in. and 120 ft. of 4-in. wrought pipe and fittings | 272.00 |
| Material bought second hand, including all fittings for 10-in. line, also 6-in., 8-in., and 10-in. fittings for pumps, 150 ft. 4-in. rubber hose and nozzles; 350 ft. of 30-in. No. 12 gage troughing, used two months on Lyons Dam | 800.00 |
| 500 ft. No. 12 gage 30-in. trough | 250.00 |
| Pulleys, belting, 3-in. cotton mill hose and other sundries | 200.00 |
| Total | $3,741.95 |

Charge 50% to next job, leaving $1,870.98 divided by 104,000 cu. yds. = $0.018 proportionate cost of plant, per cu. yd. of dirt moved.

| | |
|---|---|
| Pay roll, June 30 to Sept. 3 | $3,774.61 |
| Teams (removing stumps and stone, handling trough and trestle timber) | 248.50 |
| Straw | 18.00 |
| Oil, waste, pump repairs and sundries | 118.89 |
| Total | $4,160.00 |

$4,160 divided by 104,000 cu. yds. = 4 cts. per cu. yd. of dirt moved.

Power: Measured at meter at Big Rapids Dam, 18 miles from Croton.

| | KW.-hours. |
|---|---|
| July | 56,433 |
| August | 62,575 |
| | 119,008 |
| Add for June 25 to 31 and Sept. 1 to 3 | 19,000 |
| | 138,008 |
| Deduct for line and transformer losses and for power used for other purposes at Croton | 46,008 |
| | 92,000 |

92,000 KW.-hrs. at 1 ct. = $920; divided by 104,000 = $0.0088 per cu. yd. of dirt moved.

| Summary: Cost per cu. yd. of dirt moved | |
|---|---|
| Cost of plant | $0.0180 |
| Labor and supplies | 0.0400 |
| Power | 0.0088 |
| Motor rental | 0.0012 |
| Total | $0.0680 |

FIG. 4. HYDRAULIC EXCAVATION FOR THE CROTON DAM; MUSKEGON RIVER.

nel, which did not seem to be deepened by continued use. The slippery clay, therefore, formed an excellent channel for sluicing purposes. As the material is deposited at the end of the trough line it tends to form a cone, with a slope depending upon the kind of material. The slopes of this cone, when made up of sand and gravel, seem to drain themselves immediately, so that it is possible to walk dry shod over the material while it is being deposited. In order to further compact the material in the process of deposition two lines of troughs were used, so as to keep the center of the fill low. Arrangements were made to drain off the water at the far end. In this way there would always be a pool of water and soft material in the center. Sometimes the fill was worked against a temporary dam at the end of the slope, so as to prevent the water from passing away too quickly, and giving the material a chance to settle more compactly by being deposited in water. The slopes of the finished embankment at 2 on 1 or 3 on 1, were made by setting up boards and using straw to prevent the water undermining the boards. The straw and boards being moved up the slopes as the work progressed. Toward the end of the fill, where the water passing away was more concentrated, it was necessary to use brush and crib work of 2-in. or 3-in. poles to retain the soft material at the proper slopes. These boards and pole cribs appear in Fig. 2, where the pole cribs were necessary to retain the 2:1 slope.

### DAM OF THE COMMONWEALTH POWER CO., LYONS, MICH.

The operation of a hydraulic sluicing plant for making a fill during the winter months, in Michigan, was contemplated with much anxiety. As suitable filling material was difficult to obtain otherwise, without a long haul, and as the pumps were on hand, the plant was set up and started in the latter part of November, 1906. It was first used to complete the closing of the river, by sluicing into the pool above the cut-off crib. The right bank of the river was a clay bluff, about 70 ft. high, capped with about 10 ft. of sand and gravel. The clay was so tough and compact as to be very expensive for handling by ordinary means, and the fill was made almost entirely from the sand and gravel capping of this clay. On account of the bluff not having a steep slope, several expensive trestles were necessary to carry the troughs. These trestles and the troubles from ice, made the cost of the fill much above the usual cost of such work, when more favorably situated and made in warm weather. When the temperature approached zero, the sluicing plant was stopped, and when it was again started it became necessary to blast the face of the bluff, which had become saturated with water and frozen in for several feet. Even at the cost of 33 cts. per cu. yd. for the material moved out of the sluice pit, as shown in the statement below, it is doubtful whether any other method of moving the material in the fill would have been less expensive. The sluicing plant was certainly a valuable aid in making a quick fill in the closing of the river. Also in raising the cofferdams, at times of flood, during the two months when the sluicing plant was in intermittent operation.

The construction plant at the Lyons Dam consisted of a 200-HP. steam plant, for which coal was hauled three miles (by team) from the cars. This drove an electric generator, providing 500-volt direct-current, which was used on all of the construction plant except one steam shovel. This shovel was used to take out wasteway excavation; the material was handled in 4-yd. dump cars, which were pulled out of the pit on an incline leading through the dam, by means of an electric hoist. Electric hoists were also used on the derricks, and motor-driven belted hoists on the incline by which the cement was hauled from the store house to the mixer. The construction work on the Lyons Dam was begun in March, 1906, and the plant was put in operation in March, 1907.

COST OF SLUICING FILL AT LYONS DAM.
(December and January, 1906-07.)

| | |
|---|---|
| Setting pumping plant, labor on house for same, placing pipe, etc. | $531.58 |
| Labor at power house | 577.20 |
| Labor at pump house | 486.60 |
| Sluicing labor, building troughs and trestle | 3,117.50 |
| 675 tons of coal | 1,687.50 |
| Total | $6,400.38 |

$6,400.00 divided by 23,400 = $0.273 = cost of labor per cubic yard of dirt moved.

COST OF SLUICING PLANT.

| | |
|---|---|
| Dirt moved from pit, 23,400 cu. yds., at per cu. yd. | $0.273 |
| Proportion of plant cost per cu. yd. | 0.0513 |
| Total | $0.3243 |
| 2 new 6-in. and 1 second hand 5-in. rotary fire pumps | $1,300 |
| Pipe fittings, troughs, etc. | 1,200 |
| Lumber and sundries | 500 |
| Total | $3,000 |
| Less salvage on sale of plant | $1,800 |
| Total | $1,200 |

$1,200 divided by 23,400 = $0.0513 = cost of plant per cubic yard of dirt moved.

$0.273 cost of labor per cu. yd.
0.0513 cost of plant per cu. yd.

$0.3243 total cost per cu. yd. of dirt moved.

$1,200 divided by 23,400 cu. yds. gives $0.0513 as the cost of plant per cu. yd. of earth moved.

## NEW METHODS FOR CLOSING A CREVASSE IN A MISSISSIPPI RIVER LEVEE: THE LIVE OAK CREVASSE, LOUISIANA.

By MARY W. MOUNT.*

Crevasses in the levee system which protects his fields from flood are the dread of the Mississippi River planter and of all classes of business men in the Delta region. While attempts at crevasse closing are frequently made, the difficulties of the task are very great and failure is as common as success. The Live Oak crevasse which occurred in March last, about 27 miles below New Orleans, is the most serious break that has ever been closed. The success of this work was due to the introduction of new methods, well worthy of permanent record in an engineering journal. When the swollen yellow flood of the Mississippi rose above the danger line in March, all the levees were examined and the weak ones were made more secure. The levee at Live Oak was known to have broken in former times of high water and engineers traversed every foot of it and pronounced it sound shortly before the recent break. But the levee having subsequently been bored through by crayfish, the hole they formed was enlarged by the flood waters and the levee again gave way, not in

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FIG. 5. SHEET-IRON TROUGHS AND SLUICES FOR THE HYDRAULIC FILL OF THE CROTON DAM; MUSKEGON RIVER.

fragments, inspiring hope of stemming the currents, but all at once. Six hundred acres of land were immediately overflowed. The Levee Board quickly decided to abandon all efforts toward closing the crevasse and bent all its energies towards strengthening the ends of the levee so that more would not be torn away.

Hon. Theo. S. Wilkinson,* whose many miles of sugar plantations lay not far below the scene of disaster, volunteered to close the crevasse by methods of his own, donating his time and services if the Levee Board would authorize his work. He was given a free hand and the methods which he employed have instituted a new era in crevasse closing. For the first time, a tramway has been run across the bridge work of a crevasse, saving time, labor, danger and hardship to the laborers. New machinery has been used. New methods of building cribbing and sheeting, of sacking and of filling in cribbing have been devised. Major Sidney F. Lewis, Member of the Board of State Engineers of Louisiana, assisted Mr. Wilkinson in his great undertaking.

To close a great crevasse means to collect at the scene within a few hours engineers, mechanics, railroad bridgemen, carpenters, contractors, and hundreds of laborers, supplied with a steamboat, barges, houseboats, a tug, a gasoline launch, ample supplies, searchlights and other mediums for illuminating the work at night.

Within 24 hours must be assembled selected lumber of specified sizes and lengths to build hand pile-drivers; lumber for piles, ties, braces and sheeting; railroad material and tramcars; hammers for the pile drivers, and all classes of implements and metal pieces for joining the work, together with railroad dollies and hand mauls for use in driving piles in shallow water where no currents exist.

At the Live Oak crevasse was demonstrated the necessity for large sugar sacks to hold earth, as ordinary sacks, when cast into the cribbing, were instantly emptied of their contents by the terrific current. The problem of closing the crevasse with emptied sacks at one time confronted the engineers, when Mr. Wilkinson sent a hurry order for 20,000 large sugar sacks and used these in the bottom of the cribbing, topping off with ordinary sacks where the currents were less strong. It required four men to lift each full sugar sack, and there were 92,000 sacks of earth packed into the cribbing of the Live Oak crevasse.

Crevasses can only be closed in three ways: First, straight across the break, which is rarely done on account of the deep channel cut where the levee broke; second, in front of the foreshore, if there is any; third, in the rear, in the fields behind the break.

The closing on the foreshore is universally adopted if there is any considerable foreshore to work on, for the reason that there is usually a deposit on its outer ledge, making the lands higher in front than behind; the arched shape of the outer structure makes it stronger, with a tendency for the outside pressure to close up and tighten the work. It is also much easier to convey materials close to the work by means of boats and barges. The plan of going behind

Fig. 1. Erecting Pile Drivers for Closing Live Oak Crevasse, Mississippi River Levee.

has to be resorted to only when there is no batture or outer ledge to work on. This has the disadvantage of the shape of the reversed arch, with a tendency for the work to open or pull apart. It is also next to impossible in the earlier stages of crevasse closing to convey boats and barges with material close to it, and it is more difficult to protect from drift-logs.

The Live Oak crevasse was closed in this manner: A line of levels 6 ins. higher than the water then was in the river was laid off on the inside base of the levee on each side of the break. This line of levels was for a tramway roadbed over the bridge work of the crevasse. Pieces for ten hand pile-drivers were numbered so that their erection was quickly accomplished; hammers were set in position and they were ready for work at the upper end of the crevasse, where bridgemen had already done effective pile-driving with railroad dollies till the afternoon of the second day.

On the north or upper side the arch was begun at a distance of 50 ft. from the break in the levee; on the south side, at a distance of 150 ft. from the edge of the break, because the trend of the current was in that direction and the levee had gradually worn away some 200 ft. on that side. The crevasse was 230 ft. wide when work was begun to close it. Piles were driven here with hand mauls for a day until the work had progressed into currents too strong for the maul work.

Pile-drivers were bolted together in pairs of two each, side by side, making four hammers working together in one frame to drive four piles in a parallel line. Fig. 1 shows these pile-drivers under erection, and Fig. 2 shows the two sets of four pile-drivers each. These frequently drove 4 × 4-in. piles 12 ft. into the ground. A pile was placed in position for each of the four hammers, and was driven with twelve men pulling the rope attached to each hammer. As soon as the four piles were driven a cap piece 20 ft. long (see Fig. 3) was spiked on to the front of the four piles, the ends of the cap extending on each side beyond the outer rows of piles a little over 2 ft., so as to have a projection to carry a walkway on each side, two planks wide. The width of the construction between the outside piles was 24 ft., with 3 ft. between the piles, or bents, longitudinally. After the cap was spiked to the piles the drivers were quickly pushed forward another 3 ft. and a new row of piles placed in position and driven.

As soon as the pile-drivers were moved forward sufficiently a "hinged brace" was fitted in between the third and fourth longitudinal row of piles every 6 ft., and spiked in its place. This brace is new in crevasse work. It consisted of a single 4 × 4-in. central and two 2 × 6-in. side pieces, with a ¾-in. bolt passed through the bottom of all three pieces. When bolted together the three pieces were pushed down in the water in a perpendicular position alongside one of the back piles. The two side pieces were then leaned a little backwards, so as to pass, one on each side of the pile. The center-piece, or brace proper, was then leaned forward (see Fig. 3) until its beveled end touched one of the two lines of piles to which it was spiked. A small cleat was then nailed on the pile above the upper end of the brace. These braces require to be made with precision. The depth of water was taken where each brace was to be placed and, with these measurements laid out on frames, the length of each brace and the bevel of its top end could be accurately made.

This new method of bracing proved of wonderful efficiency. It held the bridge work rigid in the swiftest currents. In most crevasse work the so-called brace has one end stuck down in the mud, and, sinking gradually deeper in that yielding medium as lateral pressure is exerted, with nothing to hold its bottom rigid, it soon ceases to be a brace.

The bridge work constituting the frame in which was to be set the intermediate piling to hold the sacks was completed on March 11. The strong current caused scarcely a tremor in any part of the frame, and not a single pile driven by the pile-drivers was washed up, and not a single brace moved perceptibly from its position.

Drift-logs had brought to grief, at the Davis crevasse, years before, the combined efforts of two great trunk railroads, and the Live Oak crevasse work came near being irreparably injured from the same cause. It was possible to keep most of these logs out in the day time by having a tug with men in skiffs stationed above the crevasse to watch out for, rope and tow them beyond the limit of the crevasse's suction, but night and fog rendered human means unavailing to prevent their onslaught. On the night of March 12 a portion of the first and second lines of piles was broken off. The third and fourth lines held intact until morning when, by means of rope and tackle, the log was pulled out of the work. This task required the labor of

*Godchaux Building, New Orleans, La.

FIG. 2. THE LIVE OAK CREVASSE NEARLY BRIDGED.

nearly thirty men for over eight hours, as well as the use of two sets of triple blocks, compounded, exercising power enough to break a new 1¼-in. rope. One set of pile-drivers was then reversed, both broken lines of piling driven over again and made stronger than before.

After the bridge work was joined, the interlacing work, or driving of intermediate piles, was commenced. These piles needed to be close enough to hold the earth sacks. In comparatively shallow water the piles were driven by hand mauls and railroad dollies, but in strong currents and in the channel, where the water was over 12 ft. deep, pile-drivers were used.

During all the time that the construction work was being carried forward, 92,000 sacks were being filled with earth and piled up on each side of the roadbed.

A new feature introduced in this work was the building of a large number of sack holders, each holding six sacks at a time while they were being filled, which greatly expedited the work. The fact that these sacks were to be carried to the cribbing on tramcars instead of on men's backs also ensured every sack being filled to its capacity, another valuable feature in crevasse closing.

The tramcars, in trains of five or six cars each, drawn by one mule and with two men pushing each car over the work, usually came on at a gallop, the men on a full run, enjoying the novelty of the work like children out for a holiday. Some of the filled sacks and also a car load ready for hauling are shown by Fig. 4.

In all previous crevasses laborers have stood in water up to their waists or armpits, buffeted by the waves, and were frequently rendered unfit for work from this cause. Sack carriers, even with half-filled sacks, broke down under the strain of their work. Sack holders and the tramway saved the men from arduous lifting and they were not obliged to get even their feet wet, while the tramway made possible the transportation of the heavy sugar sacks, without which the crevasse could not have been checked, besides rapidly transporting material to the work.

Neither could construction in the channels have been accomplished without the use of the light hand pile-drivers, operating four hammers upon four piles at once, and arranged to move forward as one machine, making it possible to fasten the cross-beam accurately, hitherto a very difficult thing to do in crevasse work.

In the Live Oak crevasse another new feature was the abolition of the coffer-dam, formerly considered indispensable in closing crevasses.

A low level was adopted for the bridge work of this crevasse, as it permitted stronger work and deeper penetration of piles of a given length, but it was not meant to meet a rising river. To protect the work from a second rise, threatened from the Ohio valley, 2-in. tongued and grooved sheet-piling (Fig. 5), with a line of stringers inside and out at the top, and another line of double stringers just above the water line, was driven on the river side and directly in front of the cribbing. This wall was braced every 6 ft. to the caps of the cribwork behind it. The open space between the cribwork and the sheet-piling was filled in with loose earth, rammed, and substantial and permanent runways for wheelbarrows were made inside and outside of the sheet-piling, entirely around the whole work.

A total of 467 laborers were employed on this work, the cost of which amounted to $24,589, a remarkably low figure for such an undertaking.

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AN ILLINOIS RIVER DEEP WATERWAY to be built by the State of Illinois is to be voted upon at the general election in Illinois next year. Both branches of the Legislature have unanimously adopted a resolution for a constitutional amendment permitting the State to undertake the work. If ratified, the Legislature in 1909 is authorized to enact appropriate legislation and provide for the issue of not exceeding $20,000,000 bonds at a rate of interest not exceeding 4%. The purpose is to establish a deep waterway from Lockport to Utica, that is, from the terminus of the Sanitary Canal to the beginning of navigation on the Illinois River. The proposition also provides that all the water power developed shall be the property of the State and all revenues therefrom shall be converted into the State treasury.

## THE INTERNATIONAL CONGRESS FOR HYGIENE AND DEMOGRAPHY.*

By a SPECIAL CORRESPONDENT.

The 14th International Congress for Hygiene and Demography met at Berlin in the week of Sept. 22 to 29.

In view of the fact that the next Congress is to be held at Washington three years hence, the proceedings of the meeting at Berlin will probably be of more than ordinary interest to engineers. It is not too soon to make preparations for the next convention, for, if the experience gained at Berlin counts for anything, it points to the need of adequate and suitable preparation to provide for the business, the convenience and the comfort of the large number of people who will be present in Washington in 1910. Interested in the common cause of advancing the hygienic interests of mankind, the delegates and members of the Congress will be certain to offer widely differing subjects, and speaking different languages, the problems of organization for the despatch of business will alone offer serious difficulties. At Berlin these difficulties were not overcome. There were over 3,500 persons at the Congress, and it is safe to say that none found the arrangements satisfactory. It was extremely difficult for any one to make out for himself a program which would use his time economically. Most of the persons present were, of course, German, and yet papers were read and discussions offered in three different languages. An effort was made to print and distribute, weeks in advance, the main conclusions arrived at by the writers of the papers, and, so far as practicable, these conclusions were printed in French, English and German. But all the papers were not so printed, and all the persons present were not able to get the advance copies, even at the meetings; and of the translations some were so imperfect that the sense was lost.

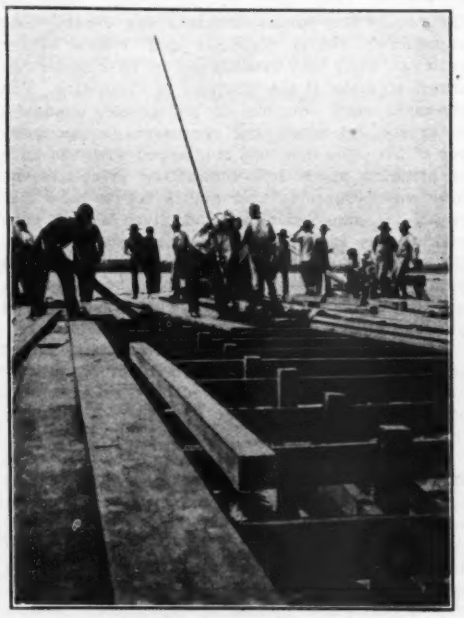

Fig. 3. Piles Capped and Bracing Being Placed.

Fig. 4. Sugar Sacks Filled with Earth and Also Sacks Loaded Ready for Filling Live Oak Crevasse.

The speakers were of several classes. There were scientists of international renown, and there were promoters of inventions and patented processes, all speaking, apparently, on equal terms. With three years of time for preparation the Americans should greatly improve on the Berlin method in every particular.

These words of criticism do not mean that the Congress was not a success. It was probably the most important as well as the largest, gathering of hygienists which has yet taken place. It means, simply, that although planned with great elaborateness of detail, the meeting was attended with much confusion and inconvenience in every possible respect. It was too large to be manageable.

All branches of hygiene were represented in the Congress, including hygiene of food and clothing, construction of hospitals, disinfection, statistics of health, morbidity and mortality, water supply, sewage disposal, street cleaning and refuse disposal, campaigns against tuberculosis and other infectious diseases, and efforts for the suppression of quackery in medicine. Each general subject was represented in a separate division, each division having its own meeting room and organization of officers. The meetings for the reading and discussion of papers were held in the Reichstag Building, a very large and handsome structure, conveniently located. Here also was held an exhibition of apparatus and models used in hygienic work in all branches.

This exhibition was especially worthy of note. The exhibitors were, with few exceptions, cities, hygienic institutes and other official bodies. In some cases large models of sewage disposal plants, refuse destructors and hospitals were shown, a few ranging in size up to 30 ft. in length. Notable among these were the sewage disposal works of Hamburg, Kiel and Cologne, the water purifying works of Berlin, and various processes of sewage disposal being tested by the Royal Institute for Examining and Testing Methods of Water Supply and Sewage Disposal. The city of Rio de Janiero had an exhibit of its anti-yellow-fever campaign which attracted much notice. The city of Magdeburg had a large model of its Puech filters, intended to handle turbid waters preliminary to slow filtration. The city

FIG. 5. SHEET PILING AND BRACING, RIVER SIDE OF CRIBWORK USED IN CLOSING LIVE OAK CREVASSE.

*Through the kindness of one of the Americans in attendance we are enabled to present (1) an interesting general report of the Congress and of the various related matters coming to the attention of the delegates, the whole prefaced by suggestions for making the next Congress an even more useful one than the one just held; and (2) summaries of a large number of papers read at the Congress. Our summaries are reprints, generally somewhat condensed, from pamphlets distributed before and at the Congress. —Ed.

of Kiel exhibited a model of its Horbertz refuse destructors, with very small cells, large combustion chambers and other special arrangements. Studies of the smoke nuisance, with special apparatus for air analysis, were graphically represented by the Technical High School of Dresden. Remarkable pictures to show the danger of the pollution of wells and the proper methods of fumigating houses after cases of infectious disease were exhibited by the Royal Hygienic Institute of Konigsberg.

The practical applications of bacteriology to the detection and prevention of infectious diseases were shown by cultures of bacteria, by photographs and wall drawings, and by microscope exhibits from many institutes devoted to this kind of instruction. It was, indeed, a revelation to many persons to see how clearly and convincingly this kind of instruction could be given. One of the most masterly exhibits was that of the Imperial Board of Health of Germany, in which were shown by diagrams, models and plastic representations many carefully collected data concerning the vital statistics of the empire.

Various phases of scientific research in typhoid fever, malaria and other infectious diseases of interest to engineers were shown by the Royal Institute for Infectious Diseases of Berlin, by means of apparatus, cultures and wall drawings. The questions of disinfection, biological examination of milk, methods of estimating the putrefactive capacity of sewage effluents, and many other matters of kindred interest, were shown by the same authorities.

The Hygienic Institute of the University of Berlin had 24 exhibits, including a respiration calorimeter to determine the quantity of heat, moisture, carbonic acid and other wastes produced by animals, as well as the consumption of oxygen and other essentials for life.

The Prussian War Office exhibited transportable laboratories and water purifying plants, as well as ventilating devices for rooms and other apparatus.

The community of Deutsch-Wilmersdorf exhibited a model of its new biologic sewage purification plant at Stahnsdorf, designed for a population of 200,000, the largest plant of percolating filters in Germany.

The purification of water for the removal of iron was shown by the Hygienic Institute of Posen and by the city of Berlin.

The ozonization of water was shown by the proprietors of the De Frise system and the Siemens & Halske system. The latter had a complete plant built in the courtyard of the Reichstag Building.

But it is impossible to even mention here each of the objects of interest in this exhibition, for want of space. The exhibits were divided into 12 chief groups, each of which was subdivided into many parts. There were, in all, 144 divisions, each of which contained material to cover from 1 to 60 subjects.

Of scarcely secondary interest to the meetings and hygienic exhibition were excursions to points of sanitary importance in and near Berlin. Berlin is perhaps the most distinctly modern large city in Europe, and its numerous sanitary works and institutions are considered to be models of their kind. Many are surprisingly large and new.

The Imperial Board of Health, with which Robert Koch was connected when he carried out the fundamental work upon which modern bacteriological research is based, has headquarters here, with many departments and extensive laboratories. The laboratories for experimental work in bacteriology and protozoology, opened in 1906, consist of a main building four stories in height, eight stables, several dwelling-houses for officials, gardens, ponds and other appurtenances. The officers, assistants and helpers number 86. The expenses in 1907 are expected to exceed 694,500 marks. The board deals with all topics relating to the sanitary betterment of the people, including the hygiene of buildings, ventilation, baths, lighting, industrial hygiene, water supply and removal of offal, inclusive of preservation of watercourses from pollution, vital statistics and hygiene of ships.

The new building of the Hygienic Institute of the University of Berlin was opened in 1904. It serves for teaching scientific research as well as for practical work. Besides extensive laboratories it contains a museum and library.

The Royal Institute for Infectious Diseases was established in 1891 and opened its present location in 1900. Its chief purpose is to study and give opinions upon questions proposed by the State Department of Education, and, if necessary, take part in combating infectious diseases. The Royal Institute for Testing and Examining Water Supplies and Waste Water [sewage, etc.] was established in 1901 under the administration of the Minister of Education. The scientific staff consists of physicians, chemists, botanists, zoologists and engineers, to the number of 27. The institute is charged with the duty of bringing about and conducting investigations into water supplies and plants for sewage disposal. It also examines and gives advice concerning the samples of water, refuse, soils, etc. On request the institute tests models of proposed plants of new design, and takes charge of the working of large plants for water and sewage purification.

Besides these institutions there were eight others devoted to the advancement of theoretical and practical hygiene, visited by those members of the Congress who were able to find time for this purpose.

Of special interest to engineers was the Royal Museum for Traffic and Construction, opened in 1906. Its principal function is to give a representation of the actual state of traffic and construction at the present time, but the historical development of present-day construction and maintenance is not neglected. There are a railway department, hydraulic department, and a department for elevated structures not railways. A large collection of models, drawings and graphic and tabular representations, is shown.

Beyond this large array of noteworthy exhibits were no less than 82 institutions, including hospitals, markets, workmen's dwellings, barracks, and industrial plants of such sanitary character as to be mentioned in the official guide book gotten up for the occasion as examples of Practical Hygiene.

Most of the engineers at the Congress visited the water-works of Berlin and the adjoining towns and inspected the methods of sewage disposal for this great community. The ways in which ground water was being procured and freed from iron, and the reasons for seeking it in preference to the filtered water of Tegelsee and Muggelsee, were subjects of much informal discussion among the visitors at the works. The average consumption of water in Berlin is now about 276,000 cu. m. or 73,000,000 gals. per 24 hrs. It is intended to develop the works until the city has a daily supply of 315,000 cu. m. or 83,000,000 gals. This, at the maximum consumption allowed for per head of 140 liters, or 37 gals., would be sufficient for a population of 2,250,000.

As is well known, the city of Berlin disposes of its sewage by using it to irrigate land. This land is owned by the city and consists of 16,000 hectares, or 38,000 acres, valued at 33,000,000 marks, or about $8,000,000. The cost of the plant and work of preparing the land for sewage treatment has amounted to 27,000,000 marks, or $6,000,000, more. About 20% of the land used for irrigation is let to small farmers, the city cultivating the remainder. Hay is the principal crop. In 1905, 1,646 hectares produced 56,582,608 kg. of hay, or at the rate of about 16 short tons per acre.

The methods of street cleaning were officially inspected by a committee of the Congress, and the ways of collecting and disposing of the municipal household refuse were examined by a few members informally. Particular interest attached to the contract recently entered into by the city of Charlottenburg, adjoining Berlin, whereby the refuse of Charlottenburg is to be collected and disposed of at so much per capita for a period of 15 years. The refuse is separated at the household into three parts, is separately collected and separately disposed of. The kitchen waste is fed to hogs.

Of the papers read and discussed at the Congress little need be said here. [Summaries of many of them are given below.—Ed.] There were but few engineers present, comparatively, and an opportunity could scarcely be given for such diversity of language, such large number of persons, and so many other attractions to bring out the most valuable and carefully formed conclusions. Such papers as were read will appear in due course with the Transactions of the Congress and can be seen by persons interested. Some of the papers will there be found to be well worthy of a careful perusal [as will be suggested by the summaries already mentioned.—Ed.].

Among the Americans present were:

Flick, L. A., Dr., Medical Director of the Henry Phipps Institute, Philadelphia, Pa.

Harrington, Charles, Dr., Secretary State Board of Health of Massachusetts and Professor of Hygiene at Harvard University, Boston, Mass.

Hegg, Elmer E., Dr, Secretary State Board of Health Washington, Washington.

Johnson, H. L. E., Dr., Washington, D. C.

Kober, Geo. M., M. D., LL.D., Professor of Hygiene, Georgetown University, Washington, D. C.

Ravenel, Mazyck Porcher, Dr., Professor of Bacteriology at the University of Wisconsin, Madison, Wis.

Soper, George A., Ph.D., Consulting Engineer, New York.

Wyman, Walter, Dr., Surgeon-General of the Public Health and Marine-Hospital Service, Washington, D. C.

War Department: Mac Caw, Walser D., Major Surgeon U. S. Army, Librarian Surgeon General's Office, Office of the Surgeon General, Army Medical Museum, War Department, Washington, D. C.

Navy Department: Beyer, H. G., Dr., Medical Inspector, United States Navy, Portland, Me.

State of Michigan: Vaughan, Victor C., Professor of Hygiene, University of Michigan, Ann Arbor, Mich.

Philippine Islands: Strong, Richard P., Doctor, Chief of the Government Biological Laboratory, Professor of Tropical Medicine, Government Manila Medical School, Manila.

The entertainments and amusements of an official character were numerous and largely attended. They included receptions, banquets, concerts, gala performances at the theaters, coach rides and railroad excursions, concluding with a trip to Hamburg, and formal hospitalities there. Large quantities of literature were furnished the members daily. A modest calculation of the treasures thus received would put the aggregate weight at 30 lbs. per person. Some of these gifts were really substantial—bound festschrifts describing matters of greatest sanitary importance not only in Berlin but elsewhere in the German Empire.

The Congress convened Sept. 22, informally; formally on Sept. 23. It met officially every day thereafter until Sunday, Sept. 29.

## SUMMARIES OF PAPERS.

### Smoke-Nuisance in Large Towns.

By DR. ASCHER (Königsberg i. Pr.).

The following facts speak for the injuriousness of smoke and soot:

(1) The increase in mortality due to acute pulmonary diseases which is to be observed in many civilized countries was greatest in industrial and not in agricultural districts. In the former it amounted in the case of infants to 600% in the course of 25 years. Here also there are additional differences, this mortality being higher in industrial neighborhoods having great generation of smoke (coal and iron districts) than in such with less smoke (textile districts). Among the coal miners of the Ruhr district it is twice as high as among the inhabitants of an equal age of the entire Kingdom of Prussia; in England it is many times higher among colliers, coal heavers, chimney sweepers and soot dealers than among farm hands.

Tuberculosis spreads more rapidly in smoky districts.

(2) The conclusions derived from statistics that smoke and soot cause a predisposition to acute pulmonary diseases and a more rapid course of tuberculosis are confirmed by the following pathological reports.

Rabbits which inhaled moderate quantities of smoke or soot for several weeks had acute inflammation of the lungs on inhaling micro-organisms, whereas controlling animals remained healthy, and in the same manner tuberculosis had a quicker course in such animals than in those which had inhaled little or no smoke or soot.

The inhalation of sulphuric acid, an important con-

stituent of smoke, also accelerated the course of tuberculosis in rabbits.

In the case of guinea pigs, which had become anthracotic by remaining in a large town, tuberculosis had a more rapid course than in the case of controlling animals.

(3) Smoke and soot favor the formation of fogs: these, again, concentrate the injurious constituents of smoke. Smoke reduces in towns of a much larger quantity of sunlight than was supposed hitherto.

(4) The fight against coal smoke in civilized countries is one of the most important hygienic problems of the immediate future; in many districts, indeed, it is the most important. It will only be successful when it rests on a broad scientific basis, and when chemical, meteorological, technical and social conditions are taken into consideration in the same manner as sanitary conditions. For technical progress, for example the invention of a cheap gas, may under certain circumstances solve the problem, just as, for example, land reform.

(5) For the solution of such problems, in which all civilized countries are interested, an international course of action is to be recommended.

## Hygiene of Public Thoroughfares.

By GUGLIELMINETTI (Monte Carlo and Paris).

In consequence of the stupendous development of automobilism the hygiene of the public roads (and especially the campaign against dust) has become of considerable importance. Macadamized roads are no longer able to resist the strain they are subjected to, and serious drawbacks result from this fact, from the hygienic (dust and mud), as well as the economic point of view (depreciation of buildings and cultivation along the roads, in consequence of intensive motor-car traffic, considerable increase in the expenses for repairs and maintenance of the roads, highly disagreeable and often dangerous circulation in the heavy clouds of dust, etc.).

Of all remedies against dust, tarring seems to carry the day: I was the first in Europe to propose, in 1901, the lubrification of the roads, and especially to propose tarring, as a remedy against dust, after special trials carried out at Monaco with the precious assistance of H. H. the Prince of Monaco.

According to the opinion of German, British, Swiss, Italian and French engineers (who were first to develop and introduce the process), the results obtained by judicious and correct tarring are by far the best and most durable. Tar hardens the surface of macadamized roads in a manner to make them comparable to asphalt pavement.

The results have not been satisfactory in all cases: in order to obtain good results, the operation must take place on a well-maintained road, well cleaned and perfectly dry; consequently it must be carried out in dry warm weather. Liquid coal tar (liquefied by heat or by the addition of a heavy tar oil) must be spread upon the road either by hand or machine in a uniform thickness, consuming about 1,200 to 1,500 grammes per sq. m. (2.3 to 2.8 lbs. per sq. ft.).

Machine work is preferable for the purpose, in order to take advantage of periods of good weather to cover large surfaces in a few hours, while some weeks are required to do the same work by hand. The wear of macadamized roads is greatly reduced by tarring, so that the cost of the operation, 12 to 15 centimes per sq. mi. (1 to 1½ cts. per sq. yd.), are largely balanced by the saving of expenses for repairs. The objection to tarring as being too expensive is therefore unfounded. Another objection is made with reference to the mud: but the mud on tarred roads in autumn after the rain is the result of injudicious tarring (operation carried out on wet roads or under unfavorable conditions). A third reproach, to the effect that tar cannot resist for any length of time to heavy traffic, is correct; the tar cannot resist where the substratum gives way. Roads for heavy traffic must not be macadamized, but must have a harder surface.

By SCHOTTELIUS (Freiburg i. B.).

The problem of street hygiene consists in providing for the hygienic safety of the traffic on streets by means of suitable roadways, removal of all that which arises on account of dust and which is economically prejudicial and injurious to health, as well as—in new parts—in procuring sufficient light and air in the streets of towns.

Among these problems, combating the dust nuisance is particularly pressing, having regard to the rapid growth of towns and to the continuously increasing street traffic.

The dust nuisance must be fought by:

(1) Teaching the public about the economic and hygienic importance of street dust. Instruction in this and in other questions of sanitation should be begun when feasible in schools.

(2) Technically correct planning of streets and suitable choice of material for the roadway. Those streets which have less traffic are to be treated differently from the principal thoroughfares, the entire population being interested in the constant removal of dust from the latter.

(3) Rational cleaning of the streets and removal of street sweepings without making dust. The employment of suction apparatus (vacuum or compressed air) is to be highly recommended for removing street-dust.

(4) Regular abundant sprinkling of the streets with water, or binding the dust by means of oils which are soluble in water, or by means of tar, or material similar to asphalt.

## The Disease of Caisson Workers.

By J. P. LANGLOIS, Professor at the Faculty of Medicine of Paris.

The proposed regulation is itself the conclusion for this report:

(1) Speed of compression uniformly fixed at 4 minutes per atmosphere.

(2) Speed of decompression gradually reduced with the number of atmospheres: 10 minutes per atmosphere below 2 effective atmospheres, 15 minutes between 3 and 2; 20 minutes above 3 atmospheres.

(3) Length of shift varying between 8 and 4 hours, according to the pressure.

(4) Recompression apparatus for work in pressures of above 2 atmospheres.

(5) Room for rest on the working premises and lodging of the workmen in the immediate neighborhood, for work in pressures of above 2.5 atmospheres.

By DR. PHILIPP SILBERSTERN.

(1) The caisson workers occupied in highly compressed air are showing a high rate of morbidity, invalidity and mortality.

(2) The typical disease of the caisson and all other workers moving about in compressed air must be defined as aeraemia. It is produced by large quantities of the gases of the surrounding atmosphere (chiefly nitrogen) being absorbed in compressed air by the blood and the liquids of the tissues, and being expelled in the shape of small bubbles, when the pressure is rapidly reduced. Besides the aeraemia, but of less importance, are the affections of the tympanic membrane and the middle ear, caused by a too rapid compression.

(3) Aeraemia can produce sudden, impetuous, often fugitive, sometimes perilous disturbances in many vascular regions. The most noticeable are air embolism in the regions of the pulmonary circulation, paralysis of the dorsal spine due to ischaemia, phenomena of Ménière, pains in the muscles and articulations.

(4) By returning sick caisson workers into compressed air, the heavy injuries of aeraemia can be prevented. This measure must, however, be resorted to immediately and consequently lodgings for the compressed air workers near the place of work and a recompression chamber equipped with oxygen inhalation apparatus must be provided.

(5) The frequency and gravity of the compressed air diseases peculiar to caisson workers depend in the first place on the height of the pressure and the rapidity of its drop. Aeraemia does not appear if the pressure does not exceed at least twice the amount of the normal atmospheric pressure. Injurious concomitants can considerably increase the danger, as for instance tainted air, sudden change of temperature, rapid variations in the air pressure during the work, certain individual factors and long shifts when the pressure is very high.

(6) Sufficiently slow and uniform decompression is the most important measure for the prevention of aeraemia. The minimum period for the drop of pressure ought to be 1½ minutes for every 0.1 atmosphere of pressure.

(7) A permanent service of supervision by physicians independent of the contractors must be established in all cases where work is executed in an air pressure of more than 1.5 atmospheres above normal; the physicians must exclude from the work all persons physically unfit for it and must immediately give notice to the authorities of every case of sickness, so as to enable them to provide in time for the prevention of grave cases of disease, whereby also useful material for the statistics will be collected.

(8) As the compressed air workers are exposed to great but avoidable danger, they must be offered protection by legal measures about similar to those contained in the "caisson bill" of the Netherlands.

By HERMANN VON SCHROETTER, Dr. phil. et med. (Vienna).

Where there is foundation work done under a pressure exceeding 1.5 atmospheres, a recompression chamber (recompression being the specific remedy) of sufficient size must be provided and oxygen (in steel cylinders) must always be kept at disposal to treat sick persons.

In order not to render the existence of the recompression chamber illusory, the workmen ought to be lodged in special barracks erected in close proximity to the building premises.

Great care must also be taken (especially where the soil is impermeable) with regard to the quality of the air in the working chamber, because impurities in the air—carbonic acid (noxious gases, like sulphureted hydrogen, carbonic oxide), high temperature, moisture—favor the appearance of pathologic symptoms during the period of decompression. Consequently, sufficient ventilation by means of cooled compressed air containing but little moisture and supplied at the rate of about 50 cu. m. (1,750 cu. ft.) per head and hour, as well as the use of electric light must be demanded.

In order to prevent physical fatigue, which also favors the appearance of pathologic symptoms, the duration of work in compressed air must be regulated. Up to a pressure of two asmospheres two shifts of 4 hrs. each are admissible in 24 hrs., the time required for compression and decompression being included in these periods. If the pressure amounts to 2 to 3.5 atmospheres the work time, inclusive of time for locking in and locking out, must not be longer than two shifts of 3 hrs. each per 24 hrs. A period of 8 hrs. at least must be allowed for rest between two shifts. Where work is done in depths of more than 20 m. (65 ft.) lifts ought to be used. The air lock must be easily accessible.

For the above reasons only persons in a perfect state of health (of heart, vessels and lungs) must be employed for work in compressed air; fat, plethoric individuals cannot be admitted.

The air space in the air lock must amount to a minimum of 0.6 cu. m. (210 cu. ft.) per head. During decompression, constant ventilation (simultaneous entrance of fresh compressed air) of the air lock must be provided.

Depth of respiration and acceleration of the blood circulation favor the liberation of the body from gas.

The supply of air must take place at a pressure as constant as possible. Each air supply pipe must be provided with a valve closing automatically when the pressure decreases in the periphery for any reason whatever. Spare pumps must always be kept in readiness.

## The Railway Service.

### THE DANGER OF EPIDEMIC DISEASES AND THEIR PREVENTION.

By Dr. HENRY THIERRY.

A system for cleaning passenger cars every day must be introduced. The vacuum system for sucking up, removing and destroying the dust and suspected germs, constantly deposited, constitutes a practical method which ought to be developed by the railway companies. The operation ought to be completed by wiping the floor with a wet cloth.

Service for cleaning the cars on the road ought to be organized.

Prophylactic measures with regard to the dejecta of the passengers from the water-closets upon the road are impossible. It is desirable that Section VI. should examine this question and should request the delegates of the different nations to state what practical proceedings are in use in their own countries, or might be resorted to, for removing this possible cause of infection.

The water from wells, cisterns, sources or conduits at the disposal of the public and of the railway employees in the stations and dining-cars must be the object of special care and supervision.

To facilitate the prevention of epidemics or to circumscribe their progress in Europe, the nations ought to come to an understanding regarding suitable measures to be taken in common.

This Congress is requested to demand the institution of an International Conference to provide for prophylactic measures against the spread of epidemics on railways and public roads.

### DANGERS FROM THE EMPLOYMENT IN THE RAILWAY SERVICE OF PERSONS AFFECTED WITH NERVOUS COMPLAINTS.

By Dr. PLACZEK, Neurologist in Berlin.

Those nervous diseases which limit or paralyze the power of action may be considered as being dangerous to railroad traffic.

As such nervous diseases the following enter into consideration:

(1) Mental disturbances in the broadest sense. According to the tables of the Prussian railroad statistics, the number of railroad officials with mental disorders is shockingly large, even though these statistics merely mention those patients interned in insane asylums. In reality the number is far greater as those patients in private or family treatment form an important contingency. The patient with paralysis becomes a source of danger through his laxity of connection in associative thought, primarily on account of the premature disturbance of his memory, through his intellectual weakness and his lack of power of opinion, through the reduction of his receptivity for external impressions and through his general ethical weakness.

(2) The occurrence of mental disorders among railroad employees is, to a great extent, to be avoided by a critical utilization of the various premonitory symptoms, which may cause the professional man to suspect the appearance of a mental disease.

(3) Persons subjected to epileptic, epileptoid or hysterical attacks are absolutely unqualified for railroad service.

(4) Apoplexies can be avoided by opportunely eliminating all perons with arterio-sclerosis or heart disease and by opportunely diagnosing diseases of the brain.

(5) Highly neurasthenic persons, i. e., those having a restless, unsettled and nervous, excitable disposition; also persons with a pronounced tendency to fatigue, with inability of decision, those possessed of feelings of fear, despondency, compulsive thought, compulsive sensibility and compulsive action are unqualified for positions in the railroad service.

The physical requirements for employment in the railroad service are to be augmented by physical and psychical requirements.

The new schedule which was presented before the commission of German railroad physicians on April 29, 1906, is to be enlarged upon to such an extent that the strict adherence to its requirements will make possible a thorough prophylaxis against the dangers resulting from disease.

INJURIES INCURRED IN RAILWAY TRAVELING AND THEIR PREVENTION.

By HUGO R. v. BRITTO, M.D., Superior Counsellor of the Board of Health (Vienna).

The absolute as well as the relative number of notices of accidents is constantly and rapidly increasing on account of the spreading knowledge of the legislative measures and of the consequent endeavors on the part of the employées to draw the utmost advantage from the situation, in order to obtain compensations and, especially, pensions.

In order to carry out the railway service with the least possible danger, the employment of physically and mentally quite sound servants is a primary condition.

The prescriptions regarding the regular hours for service and for rest must be correctly carried into effect and hygienically suitable localities for repose during day and night must be provided.

The consumption of alcohol during service hours must be limited as much as possible; drunkenness during service must be punished with immediate withdrawal from active service and in the case of a repetition with dismissal.

## Sewerage and Sewage Purification.

UP-TO-DATE EXPERIENCES ON THE SEPARATE SYSTEM OF SEWERAGE.

By Carl GUENTHER (Berlin).

The separate system for the discharge of sewage, as introduced in Germany a number of years back in numerous localities, has so far given satisfactory results. Up to the present time the separate system has principally been introduced in small localities. In larger places it is seldom used for the whole extent of the ground built upon, but is mostly restricted to smaller districts of the municipal territory.

For the preference of the separate system over the combined system, local reasons of the most various kind have been determinative in the different cases. Hygienic considerations were in the front rank among them. Special regard had to be given the state of purity of the water course into which the discharge is effected. Where hygienic considerations left the choice between the separate and the combined system open, technical reasons came to the fore to influence the choice. In that case the question of expense has generally turned the scales. With the separate system the expenses for plant and working of the canalization and the purification of sewage are often lower than they would be for the combined system.

By H. ALFRED ROECHLING, Civil Engineer (London).

When I now come to consider the question, whether recent experience has confirmed the former views concerning the separate system, I have no hesitation in saying that in the main it has undoubtedly done so. It is impossible to lay down hard and fast rules for the applicability of the separate system in every case.

Nature and man impose conditions which are not alike in two cases. And herein lies the skill of him who has to advise in matters of this kind, to patiently and diligently bring out all the points that require consideration, to assign the due weight to each, to sort as it were the chaff from the wheat and to evolve finally a scheme, that while offending as few of the minor points as possible does full and ample justice to all the leading conditions. Here as in many other questions the old proverb holds true: Examine everything and retain only the best.

INFLUENCE OF CLARIFIED SEWAGE UPON THE CONDITION OF RIVERS.

By Dr. KISSKALT (Berlin).

There is no purifying method by which sewage is freed from all impurities and returned in the state which the water would have had if it had flowed into the watercourse in the natural way. The modifications which the water courses are subject to through the discharge of purified sewage into them, vary according to the quantity and quality of the sewage, quantity, quality and movement of their own water, quality of their bed, possibility of access of oxygen and quantity of plankton.

All rivers into which purified sewage is discharged ought to be regularly and frequently examined, although no complaints on the part of the riverside dwellers may be made. Most methods of examination are unsatisfactory and ought to be improved in many details.

The number of pathogenic bacteria in the sewage is reduced by all methods of purification. But the merits of the various clarifying methods are not all alike. The least satisfactory is the mechanical method; somewhat better results are obtained by means of the chemical, and still better results by the oxidizing process; under circumstances, sewaged land is sure to retain all pathogenic bacteria.

Primary putrefaction must not occur in the water course with natural or artificial biological purification; if it occurs with sewage purified in another manner, there is proof that the purifying process is not suitable for the size of the water course used. The separation of ingredients added to the sewage to assist deposits is specially annoying. If moderate quantities of organic food stuffs get into small water courses, strong development of saprophytic germs may take place or fungi may grow and secondary putrefaction arise. Nitrates and nitrites may give rise to an exuberant growth of green plants of higher or lower order, the putrefaction of which, especially if they are algae, likewise causes annoyance.

By Dr. BORDAS (Paris).

The sewage of towns and the waste water of factories must only be discharged into streams, rivers or water courses, after previous purification.

Town sewage, after clarification by means of irrigation or by purification from bacteria, must be freed from all pathogenic germs, before being discharged into water courses.

To attain this latter end, the clarified water must be treated with permanganate of lime or soda, manganate of soda, etc., in doses of 50 centigrammes per cu. m.

UTILIZATION AND REMOVAL OF SEWAGE SLUDGE.

By Town Councillor METZGER (Bromberg).

The irrigation method is superior to all other methods of purification with regard to realizing the value of and removing sludge. Preference should therefore be given to irrigation, more than it has been hitherto, even if the sludge must be conveyed by machinery to land at a distance.

The collection of sludge in the neighborhood of settling works is to be avoided, in so far as these are near the town, as annoyance on account of smell, flies and other insects which collect in large numbers, and transport later, are not to be avoided. Also the value of the sludge is reduced to a minimum, if not entirely done away with, by the high costs of carriage.

The realization of the value and the removal of sludge is of so great importance that settling works should not be carried out until all the questions relating to the later treatment of the sludge are finally decided in principle, known defects being avoided.

REPORT ON THE EFFECT OF THE MECHANICAL, CHEMICAL AND BIOLOGICAL PURIFICATION OF SEWAGE.

By Prof. SCHMIDTMANN* (Berlin).

(1) There is no method of clarifying waste water which is suitable for all cases, generally satisfactory and capable of universal employment.

Results can be obtained with every mode of clarifying waste water, in a manner which is sufficient for practical requirements, when the method is chosen correctly according to the conditions of the individual case, is suited in its arrangements to the locality and is operated regularly under expert control.

(2) The requirements which are to be made in the interest of the public on the degree of purity of the clarified waste water are not fixed, but are to be determined in each individual case with exact examination of all the conditions. As a rule, the maximum or minimum is determined according to the requirements which must be made in the interest of the care of health. With the fulfilment of the sanitary requirements, all moderate demands for clarification of waste-water are generally satisfied which are made in domestic, agricultural, industrial and fishing interests, apart from special cases.

(3) When the degree of purity which is to be demanded according to the given conditions can be obtained with a simple process, extensive and expensive clarification cannot be justly demanded. The plant to be erected must, however, be made as perfect of its kind as possible with all the means of the art. Many failures are explained by the improper curtailment of construction cost.

(4) The relatively most certain success in removing waste water without objection, particularly when it is a question of large quantities, is offered by purification by means of distribution on sufficiently extensive areas of land of suitable nature (irrigation, Eduardsfeld method, intermittent ground filtration, underground irrigation).

(5) The purifying effect which is to be aimed at by the natural biological process of treating the ground can be obtained by the artificial biological method, in a similar manner, apart from the influence of infectious matter.

The aim of biological purification of sewage by material placed artifically in layers must be, generally speaking, the production of a discharge which is incapable of causing putrefaction.

The results of biological purification depend, above all, on working the plant suitably; also on correct proportions, suitable previous treatment and, if necessary, subsequent treatment, suitable choice of material and the mode of distribution of the sewage over the material.

*Head of the Royal Testing Laboratory for Water and Sewage Purification.

For securing suitable working, besides a [illegible]ing an educated staff, a control book and a regular [illegible]able examination of the discharge are necessary.

(6) The chemical purification of sewage [illegible] recently been pushed into the background by the b[illegible]al process and by the improved formation of the [illegible]hanical method; nevertheless, in many cases, parti[illegible]y when it is a question of industrial waste water, [illegible] employment of chemical means of precipitation, by [illegible]selves alone, or in combination with other methods [illegible]clarification, is of value even at the present day, [illegible]n some circumstances even indispensable.

(7) The mechanical clarification [sedimen[illegible]on?] of waste water by means of basins, wells or to[illegible], especially in Germany, has been maintained with favorable conditions of in-flow and suitable development. In order to obtain a satisfactory result, it is indispensable to have a correct individual formation of the basin or well suited to the given conditions, as well as an appropriate working of the plant, especially opportune provision for removing the sludge in a manner which is free from objection. The methods [septic tanks, etc. ?] which have been recently employed for separating the sludge in the basins or wells during working from the waste water flowing through, and allowing it to rot away (Hampton, Essen, Recklinghausen) are worthy of consideration.

(8) In order to obtain satisfactory results with grate installations [screens?], especial care must be taken in forming the same that trituration of the floating dirty matter be avoided as much as possible. Well formed grate installations may be employed as exclusive independent means of clarification when very specially favorable conditions of inflow exist.

(9) By excluding manual labor as much as possible, and by an extensive employment of automatic methods of operation, the health of workmen at clarification plants may be promoted to a considerable extent, as experience at Frankfort-on-the-Main, has conclusively shown.

(10) The costs of the individual methods of purifying sewage are, generally speaking, very nearly in direct proportion to the result of purification which is to be obtained in each case. A numerical comparison of the results of purification of the different systems of clarification is exceedingly difficult in individual cases. Only the subordinate kinds within the individual methods of purification can be compared with some certainty. Thus, for example, a suitably constructed grate installation with sand collectors may be estimated in its capability of separating undissolved dirty matter to about one-third to one-half of that performed by large basins or wells.

(11) The continual combination of disinfection with the working of central clarification is not to be recommended; it is rather to be limited to exceptional cases (epidemics). The destruction of infectious matter is, as a rule, to be carried out at the place where it originates, but even at central clarifying plants one must be prepared for the possibility of it being necessary to disinfect the whole of the sewage. For this purpose series connection must be arranged at basin and well plant; at biological plants the subsequent clarifying basin is to be formed capable of use for disinfection. Where the possibility of disinfection cannot be secured constructively, land must be kept ready at the plant on which ad hoc disinfection basins may be erected.

(12) Only a regular expert examination of the discharge from the clarifying plant and of the inflow gives a correct picture of the action of the plant. The extent and kind of examination depends on the method of clarification in each case.

(13) The bacteriological examination may as a rule be dispensed with when judging the effluent of any clarification plant; it comes into consideration, however, when it is a question of disinfected effluent; it must then be determined whether the discharge still contains bacilli of the group of bacterium coli.

[A paper dealing with sewage treatment in tropical countries was presented by Dr. Gilbert J. Fowler, Consulting Chemist of the sewage works of Manchester, England. Unfortunately an abstract of this paper could not be obtained by our representative.

Mr. Armond Puech, who is the proprietor and promoter of patented systems of both sewage and water treatment, read papers exploiting each. In brief, Mr. Puech employs preliminary or roughing filters in batteries, each successive unit of which consists of a finer grade of gravel or sand than that of the previous unit.—Ed.]

## Water and Water Purification.

EXPERIENCES ON WATER COLLECTED BY VALLEY DIKES [IMPOUNDING DAMS].

By Prof. FRAENKEL (Halle).

According to origin and quality, the water collected by valley dikes [impounding dams] is essentially surface water, but sometimes also contains a certain quantity of underground and rain water which may be considerable under circumstances.

The number of germs contained in such water is also

considerably reduced, so that the supplementary purification of the water by filtration with sand filters has sometimes been considered as superfluous in the case of a correctly erected and regularly-worked valley dike. This opinion might indeed be accepted as justified, if the situation of the reservoir makes any soiling by sewage from towns, villages, human dwellings, etc., absolutely impossible, and if suitable measures are taken to maintain the state of purity. The reservoir must be surrounded by an impenetrable hedge of trees and shrubs; all bathing on the water, etc., must absolutely be prohibited; any impurity coming from the storage dam must be carefully kept away; the dike must be completely cut off from all human traffic and contact; in short, the whole plant must be protected and secured to the utmost possible extent.

To keep the reservoir clean of vegetable impurities, which are liable to produce a deterioration of the taste of the water, especially at the time of decay in autumn and winter, the whole area to be used for the storage ought to be cleared of all trees, shrubs, grass, etc., and especially also of all vegetable earth.

On the whole, dike water is preferable by far for man to surface water, i. e., to the contents of rivers, streams, brooks and lakes, because it does not contain so many impurities and especially pathogenic substances, and because it has a far better taste on account of its uniform temperature.

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## OZONIZING WATER FOR USE IN TOWNS.

By JULES COURMONT and LEON LACOMME (Lyon).

If we go by the conclusions which may generally be drawn from the industrial use of ozone, in France, for the sterilization of drinking water, we may specially mention the following points:

(1) The sterilization of water by ozone is being carried out industrially for large quantities of water by means of three different processes, viz.: Abraham and Marmier (Lille, Cosne), Tindal-de Frise (St. Maur), Otto (Nice). The ozonization of drinking water is therefore an established fact of the highest importance.

(2) Ozonization can only be applied to clear water, i. e., (a) direct to spring water which never becomes turbid, although frequently polluted (Paris) and to lake water; (b) after filtration (at least for gross impurities) to spring water which can become turbid or to river water.

(3) Although the plants mentioned have given the expected results, it is yet impossible to say that these results have always been excellent. That does not condemn the method of water sterilization by ozone, but the following points must be thoroughly examined from the industrial point of view: (a) the apparatus must be kept under constant supervision by a responsible engineer; (b) the registers must work without interruption; (c) the results must be controlled by means of frequent bacteriologic analyses; (d) the expenses for supervision and control are only bearable in connection with plants of a large size.

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## NEW METHODS OF FILTERING DRINKING WATER.

Dr. ED. IMBEAUX, Chief Engineer for Roads and Bridges and of the City of Nancy (France), with a note by Mr. ALLEN HAZEN, Consulting Engineer, New York, on Mechanical Filters in the United States.

To sum up, with regard to the methods of filtering drinking water on a large scale, we consider that attention should be called to the following points:

(1) Natural filtration, if regulated artifically, can give excellent results both as to quality and quanity if there are suitable beds of sand at disposal: the effect of fouling can be overcome as much in horizontal filtration, as in vertical filtration, be renewing the first filtering layers of sand.

(2) Slow membrane filters continue to be worthy of recommendation when this membrane is formed and maintained easily, when the supply is constant and regular, and when an efficient bacteriological inspection is assured. The formation of the membrane may be facilitated by the addition of certain substances, chiefly of coagulants, while the addition of sulphate of copper preserves it from disturbances by inferior organisms. The speed and the life of fine filters are considerably increased by pre-filtration or multiple filtration.

(3) Rapid filters (mechanical or American) are specially mentioned for river water which, being muddy a good part of the year (colloidal clay), require chemical precipitation (coagulants) in order to become clear, as well as for colored waters (yellow); moreover, they possess the advantage of requiring less space and are less expensive in their first installation.

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## DOUBLE SAND FILTRATION AND PRELIMINARY CLARIFICATION WITH SULPHATE OF ALUMINA.

By EUGEN GOETZE, Dipl. Ing., Direktor of the Bremen Water-Works.

Double filtration and preliminary clarification with sulphate of alumina are improving complements of slow sand filtration, in cases where the latter is not fully sufficient. A second filter will remove without difficulty the slight residue of impurity which has still remained in the water passed through the first filter. At high water, the amount of bacteria entering into the filter with the crude water is too large for the biologic action of the filter. For a biologic final filter, water once filtered but still somewhat turbid and containing a few hundreds or even a thousand of bacteria per cubic centimetre can be filtered to perfection without difficulty. Filters newly filled or cleared do not work to perfection, so that their product will be imperfect for some time or at least suspicious. During these periods, the water which has gone through the first filter and is purified to a high but not sufficient degree must be passed through the second filter. In this way the loss is avoided which would arise if the water imperfectly purified in the first filter had to be rejected, so that the expenses for the first filtration and for raising the water would have been thrown away.

Double filtration is a saving of working expenses. Only under special circumstances a larger filtering surface than the normal is required and in no case twice as large a surface is necessary as for single filtration.

By previous purification with sulphate of alumina a large part of the purifying work is transferred to the sedimentation basin, where the crude water is improved in quality and is made more easy to be filtered.

Clarifying with depositing agents, especially with sulphate of alumina, is not really a chemical treatment of the water, but rather a mechanical one and need not give rise to hygienic apprehensions.

The arsenic contained in the sulphate of alumina in its usual state as good merchantable article, is extremely small in quantity and no fears need be entertained on that account; besides, the arsenic enters into insoluble combinations and is thus eliminated. Any fears about this kind of treatment are therefore unfounded. Eventually sulphate of alumina free of arsenic can be obtained, although at a somewhat higher expense.

Through the use of depositing agents, the working expenses are somewhat increased, but the quality of the water supplied is so excellent that there ought to be no hesitation to adopt the process.

The two supplementary operations of occasional previous clarification with depositing agents and double filtration impart to the filtering process a better adaptability to the various phases in working and offer greater security with regard to the quality of the water obtained.

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## Modern Methods of Combating Typhoid Fever.*

By SCHNEIDER, Privy Counselor of the Government (Saarbrück).

(1) The endemic propagation of abdominal typhoid fever requires to be combated in a systematic, uniform, permanent campaign. The fight must be directed against typhoid fever and all diseases taking a similar course, especially against paratyphus and dysentery.

(2) For the object of the campaign bacteriologic stations must be established and charged with the duty to assist the public and private physicians.

(3) Uniform service instructions must be drawn up for the work to be done in the stations.

(4) Uniform schedules must be drawn up for the investigations and reports thereon to the station, and for the reports between the stations; these reports must be so arranged that

(a) They can easily be examined with regard to the completeness of the investigations made and information obtained.

(b) They contain the information required to pursue in the districts of all stations any traces discovered in any one district.

(c) Completeness of the information is secured, which is necessary to take measures against the further spread of the infectious matter.

(d) The results of the work carried out in the various stations can be compared with each other.

(5) Uniform principles must be laid down with regard to the prophylactic measures to take against any further spreading of the infectious matter, and the civil authorities must be instructed to act according to these principles with regard to isolation and disinfection or to any other measures required or admissible, according to the circumstances.

(6) As most efficient isolation, the recovery in a hospital ought to be aimed at.

(7) A sufficient number of suitable hospitals with good isolation arrangements and suitable means to transport the patients ought to be provided. Assistance must be granted out of the public funds to pay the hospital expenses for the poorer classes.

(8) Where the recovery in a hospital is not possible, professional nurses experienced in disinfection ought to be engaged.

(9) If a professional attendant cannot be obtained, provision must be made to keep away from the sick-room all persons not engaged in the care, and to secure sufficient and regular disinfection. For the latter purpose the persons entrusted with the care must be instructed and controlled by the physician in treatment or by public disinfectors.

(10) A sufficient number of disinfectors must be trained and officially appointed and their fees must be fixed by tariff.

(11) The final disinfection must always be carried out by official disinfectors.

(12) Professional superintendent disinfectors ought to be officially appointed.

(13) All sick attendants and all assistants in the hospitals ought to be instructed in disinfection and to be periodically examined and controlled by a professional disinfector.

(14) Provision ought to be made that disinfectants can always be had at cheap prices and that a sufficient number of steam disinfecting apparatus is always at disposal. The expenses for disinfection ought to be paid, entirely or partly, out of the public funds.

(15) The prophylactic measures prescribed must only be discontinued when bacteriologic recovery has been ascertained.

(16) For economic reasons the isolation of persons who after the clinical cure permanently excrete bacilli, ought not to be protracted beyond a maximum period of ten weeks from the beginning of the disease.

(17) The carriers of bacilli must be enlightened on the danger they represent for the persons in their surroundings; they must be exhorted to be very cleanly in their habits, and educated and compelled to regularly disinfect their secretions and linen and report on their state of health.

(18) More severe measures for control must be applied if the carriers of bacilli are persons occupied in the production or the sale of food-stuffs, or if they are kept in lunatic asylums, prisons, etc.

(19) Special value must be attached to ready collaboration on the part of the private physicians. They must be supplied with receptacles to use for despatching material for examination, and the despatch by post must be made as easy as possible for them and free of any expense.

(20) Search ought to be made for a suitable remedy to kill the bacilli in man before they are secreted.

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By PROF. P. FROSCH (Berlin).

(1) The usual and permanent way of propagation of endemic abdominal typhoid fever is infection by contact.

(2) The propagation is favored by light and ambulatory cases as well as by the existence of persons carrying the bacilli and secreting them for a long time.

(3) The propagation is further favored by overcrowded and unhygienic dwellings, uncleanly habits of the inhabitants, and the very objectionable proceeding of more persons than one sleeping together in the same bed.

(4) Among the substances serving for food and consumption in general, which mainly co-operate in the propagation of endemic typhoid fever, retail milk stands in the first rank.

(5) Infection through drinking water and water for domestic use must be considered as of secondary importance in the campaign against the endemic typhoid fever.

(6) Under certain local circumstances (for instance, in industrial districts with a fluctuating working population) the frequent importation or exportation of typhoid fever also constitute an important factor.

(7) In order to restrict or extirpate endemic typhoid fever, it is necessary to find out and to isolate as soon as possible all the persons who are infected by the bacillus of typhoid fever. It is also necessary to strive energetically for the radical improvement of all the hygienic conditions.

*[It should be borne in mind that the suggestions here given apply more specificially to state or federal than to city work.—Ed.]

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## The Campaign Against Yellow Fever.

By PROF. ARISTIDES AGRAMONTE (Havana, Cuba).

Exclusive measures, tending to prevent the transmission of yellow fever by the bites of mosquitos of the genus Stegomyia Calopus, have been the means by which the total extinction of epidemics was accomplished in the United States, Mexico, Cuba, Brazil and Panama.

No other methods of disinfection were employed at these campaigns, considering that "fomites" have been proven to be non-infectant as far as yellow fever is concerned.

In case of epidemic.

(1) Determine as exactly as possible the limits of the infected zone.

(2) Make a census of the non-immunes within the infected zone.

(3) Restrict the immigration of non-immune element.

(4) Provide for non-immune immigrants so as to keep them under surveillance.

(5) Consider all febrile cases in non-immunes, or in children, as suspicious cases of yellow fever.

(6) Establish an Isolation Hospital.

(7) Establish one or more Detention Stations.

(8) Place in operation the number of brigades necessary to do away with mosquito breeding places.

(9) Place in operation a sufficient number of fumigating squads.

(10) Maintain a corps of medical men to travel on the railroads leaving the infected zone for any other part of the territory.

(11) Maintain strict guard to prevent the escape of persons from the infected zone, without passing through the Detention Stations.

(12) Consider all persons whose immunity cannot be

proven as presumably non-immunes; this applies to children.

(13) The campaign must be directed from the very spot where the epidemic exists and never from some other town or state.

(14) Appoint a board of expert clinicians, with a corresponding microscopist, to aid in clearing up the diagnosis of difficult or obscure cases.

(15) In exacting from the public compliance with the above recommendations, exercise gentle persuasion, but if necessary do not hesitate to employ force.

Conclusions.

All successful campaigns against yellow fever must be based upon the following general measures:

(1) Early report of cases and their isolation.

(2) Early fumigation of infected premises and surrounding buildings.

(3) Wholesale destruction of mosquitos and their breeding places.

(4) Protection of non-immunes from the bites of mosquitos, and their segregation from the infected zone whenever possible.

(5) There is absolutely no need of any other form of disinfection.

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### The Malaria Campaign.

By DR. BRUNO GALLI-VALERIO, Professor at the University of Lausanne.

The struggle against malaria based upon our present knowledge of the protozoa by which the disease is produced, of the way of their transmission through the anophees [mosquitos] and of the causes which provoke a predisposition for infection, cannot be carried through by means of one single process, but must consist of:

(1) The destruction of the specific protozoa existing in the body of the diseased person.

(2) The immunisation of sound persons against the protozoa.

(3) The protection of infected and sound persons from being stung by anopheles.

(4) The anopheles campaign.

(5) The struggle against the causes provoking a predisposition for malarious infection.

In each case one or the other of the above proceedings will be laid special stress upon. The campaign will be completed by instruction on the ways of propagation and on the details of the struggle against malaria.

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### THE PREVENTION OF MALARIA IN BRITISH POSSESSIONS, EGYPT, AND PARTS OF AMERICA.

By RONALD ROSS, C. B., F. R. S., Professor of Tropical Medicine, University of Liverpool.

Conclusions: Necessity for regular and full reports on the local prevalence and prevention of malaria, and for the appointment of special commissioners to superintend the work.

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### THE STRUGGLE AGAINST MALARIA IN ITALY.

By PROF. CELLI (Rome).

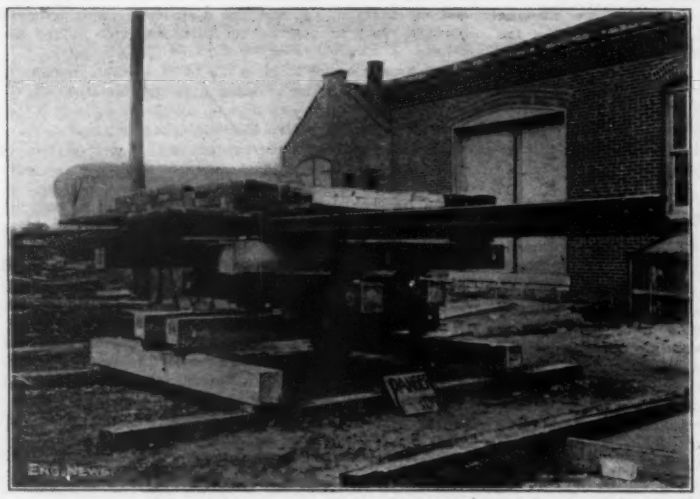
Our experience of long years' standing has taught us with reference to the fight against malaria:

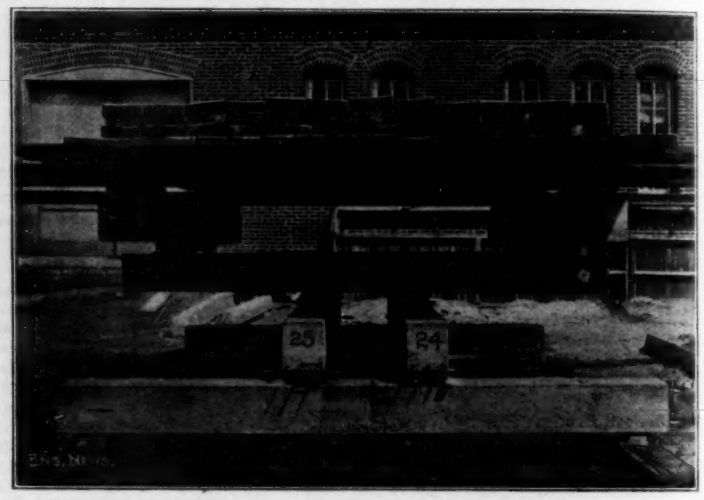
(1) That the extirpation of gnats [mosquitos] in large areas can hardly or not at all be effected direct with physical, chemical or biological means, nor indirect by hydraulic drainage. It is comparatively easier, under circumstances, to render the gnats innocuous by using mechanical means (mechanical prophylaxy) to keep them away from man and dwellings. It is in any case an undeniable fact that anopheles exist in many parts of Italy and in other countries in the whole world, while yet malaria has ceased or decreased or is about to decrease.

(2) That the destruction of the malaria parasites in the human blood is best brought about by quinine, when they begin to develop. Consequently, far easier and more rapid disinfection is secured by the prophylactic use of quinine in daily medium doses than with the curative use of the remedy. In consequence of this preventive treatment, which ought to be applied to as many inhabitants as possible during an epidemic period and in regions infected with malaria, and of constant permanent quinine treatment of all malaria patients in any season, the scourge is decreasing more and more from year to year among the respective population, although marshes and anopheles may never have ceased to exist.

(3) That, in order to obtain the greatest benefit from quinine, the preparations best tolerated by the stomach and best digested must be taken (quinine in sugar drops, chocolate tablets) in regular daily doses, so that a state of complete mithridatism is produced. The best proceeding would be that the State take the manufacture of the quinine preparations in hand and sell them at low prices; and it would be better still, if these preparations could be supplied gratis to all workmen and employees living in malaria infected regions.

(4) That man can be kept in health in any district, even the most unhealthy, by applying quinine prophylaxis (eventually supplemented by mechanic preventive measures). In this way the hydraulic and agricultural operations in any district, of any size whatever, can easily be carried out or can at least be facilitated and accelerated.





FIGS. 1 AND 2. TWO VIEWS OF ARRANGEMENT FOR CONSTANT-LOAD TEST OF REINFORCED CONCRETE BEAMS.

Then can be applied the economic and social measures, such as better nourishment, better working conditions, suitable clothing, better dwellings, which have contributed in all periods of culture, and are doing so at the present time to a far greater extent, to definitely extirpate malaria in all regions inclusive of those where anopheles have not ceased to exist.

The preceding remarks show that the various measures mentioned above as suitable for the malaria campaign do not exclude, but on the contrary supplement, each other in their practical application.

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### THE FIGHT AGAINST MALARIA IN THE GERMAN COLONIES AND IN THE IMPERIAL MARINE SINCE THE YEAR 1901.

By DR. REINHOLD RUGE, Fleet-Surgeon and Professor at Kiel University.

(1) None of the protective agents employed in fighting malaria affords an absolutely certain protection.

(2) The most simple protective agent and one which can be employed under all conditions is prophylactic quinine; nevertheless, each case must be judged on its merits according to the danger of infection and capability of taking quinine.

(a) Quinine 1.0 is to be taken with the known precautionary measures on two successive days—eighth and ninth to fifth and sixth day, according to the danger of infection in each case—or every fourth day.

(b) Quinine must be taken in the manner stated above for at least two months after the last attack of fever.

(c) Administering quinine to native servants also belongs to the prophylaxis of malaria.

(3) Mechanical protection has only recently been employed in the German colonies. If the houses which are to be protected were built suitably, and if the wire protection were arranged and kept in condition with the necessary precautionary measures, it would do good service. Mosquito nets for beds are in general use by Europeans. Zupitza has successfully protected itself from malaria in the tropics by purely mechanical protection.

## A NOTE ON THE EFFECT OF THE TIME ELEMENT IN LOADING REINFORCED CONCRETE BEAMS.*

By W. K. HATT.†

During the last two years the Laboratory for Testing Materials of Purdue University, in co-operation with the U. S. Geological Survey, has made some experiments to determine the effect of the time element in loading reinforced concrete beams. In these experiments beams were loaded in the following manner:

1. The ordinary test in which continuously increasing loads are applied until failure.
2. Loads applied a number of times from zero; starting with a repeated load causing about 3,000 lbs. per sq. in. stress in steel, and stepping up to 8,000, 16,000, 29,000 and then to failure.
3. Constant loads.
4. Impact tests.
   (a) Under increasing height at drop.
   (b) Under constant height at drop.

This paper only records the general results of these tests.

MATERIAL TESTED.—The beams were of broken-stone concrete in proportion 1: 2: 4, and were 8 ins. wide and 10 ins. in depth to the steel, under 1, 2 and 3. Ordinarily the span was fixed at 9 ft. and the loads were applied at the third-points. The percentage of steel was ordinarily 1%, but varied as shown in Table II. The age at test was intended to be 60 days. Since some of the beams were loaded nearly 2,500 times by hand, the duration of the test in some cases was nearly a month.

METHOD OF TEST.—In the ordinary tests (Process 1), loads were applied at the third-points, and deflections were measured at the center of the beam. Extensometer measurements were made of the deformations occurring at the top and bottom faces of the beam, which measurements were made in the same manner as practised at the Structural Materials Laboratory of the U. S. Geological Survey at St. Louis, Mo.

In Process 2, the details of the test were as described under Process 1, except that a certain stage of loading would be repeated a large number of times until the beam seemed to come down to its bearing under that loading. The deflection was read every tenth loading, and extensometer readings were made at intervals, usually every hundredth loading.

In Process 3, pairs of beams were piled one upon the other as shown in Figs. 1 and 2, and submitted to a constand load for a period of some two months. The span between the loading points was so varied as to cause an increase in stress in the steel from 3,000 to 8,000 to 16,000 to 29,000 lbs. per sq. in. from top pair of beams to the bottom pair of beams. Rollers were disposed between all bearing points so that the beams might act independently. Unfortunately, after the expiration of about two months, some trespassers on the laboratory grounds caused a swaying back and forth of the steel rails supporting the constant load, and threw the entire load on one of the pair of beams intended to be stressed to 16,000 lbs. in the steel. The yield point of the steel was thereby exceeded, and a large crack occurred in the concrete. The test was then interrupted, but will be renewed.

The beams for the impact tests, Process 4, were 8 x 8 ins. in cross-section, 7 ft. long, and tested on a 6 ft. span. The reinforcement was 1% of soft steel round bars of ordinary surface. In the first series, the 250-lb. weight was dropped on the center of the beam, beginning with

*A paper read before the American Society for Testing Materials, at Atlantic City, N. J., June 22, 1907.

†Professor of Civil Engineering, Purdue University, Lafayette, Ind.

the 2-in. drop and increasing by 2-in. increments until failure. In the second series, a 100-lb. hammer was dropped a large number of times from a constant height of 10 ins. In both cases, the deflection and set were recorded for each blow. The machine is described in Transactions of the American Society for Testing Materials, Vol. VI., p. 462.

RESULTS.

Processes 1 and 2.—The deflection and the set caused by the process of repeating loadings as compared with

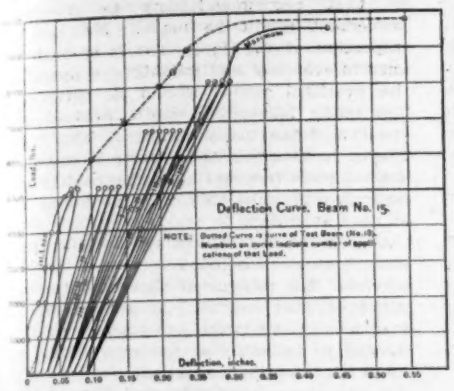
Deflection Curve. Beam No. 15.
NOTE: Dotted Curve is curve of Test Beam (No. 16). Numbers on curve indicate number of applications of that Load.
Load, lbs.
Deflection, inches.

Fig. 3.

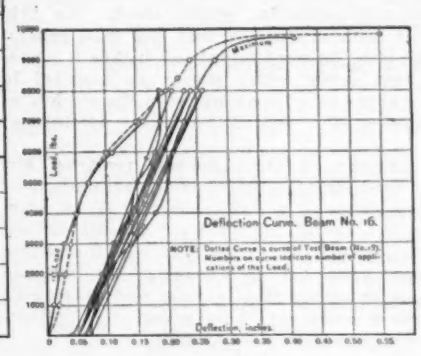
Deflection Curve. Beam No. 16.
NOTE: Dotted Curve is curve of Test Beam (No. 15). Numbers on curve indicate number of applications of that Load.
Load, lbs.
Deflection, inches.

Fig. 4.

FIGS. 3 AND 4. LOAD-DEFLECTION CURVES OF REINFORCED CONCRETE BEAM UNDER REPEATED LOADINGS.

(Beams, 8 × 10 ins., 9 ft. long. 1% Reinforcement, Round Rods.)

the usual process under a continuously applied load is shown in Table I., and illustrated in the diagrams Figs. 3 and 4. It will be seen that a stress of 16,000 lbs. per sq. in. caused a deflection of 0.14 ins., and that a repetition of loading, as shown on Beam 16, increased this deflection to 0.26-in., and in Beam 15 to 0.24-in.

There is evidently a continuously increasing deflection and set in beams under this process of repetitive loading. The question as to the source of this set and deflection must be answered by an analysis which is not at present at hand. The set is, no doubt, in both the compressed concrete and the adhesion between the steel and concrete. It is probably more largely in the compressed concrete than in adhesion.

By reference to the further diagrams Figs. 5 and 6, it will be seen that the process tends to render the ordinary deflection and deformation diagrams more straight, than they are under the ordinary loading process. The interesting exhibit in Table II. shows that this process of repetitive loading did not diminish the maximum load which the beams carried.

The repeated loadings on the beams tested in 1906 were such as to produce a stress on the steel of about two-thirds its elastic limit.

Failure was of the same character under Processes 1 and 2.

Process 3.—Table I. also shows the deflection reached by the beams which were loaded with a constant load for about two months. The deflections, as compared with those under Process 1, have increased very largely. At 16,000 lbs. per sq. in., the increase was about 100%.

These results, taken together, show a sort of plasticity in concrete, by which it yields under the action of a load applied for a long time, or applied a number of times. The rate of increase of deflection under constant load is shown in Table IV.

Process 4.—These impact tests are to be criticised because the weight of the hammer was too small in proportion to the weight of the concrete beam, and thereby the action was one of vibration as well as of deflection. Local damage of the concrete at the striking point was prevented by a steel plate. The results in Table III. are recorded as a matter of interest, rather than of significance at the present time.

A curious phenomenon was in the failure which arose in the majority of the beams under the action of the striking weight. The failure was not, as might have been expected, the cracking of the concrete at the center of the beam on the lower side in tension. On the contrary, the first indication of failure was a crack which started at the top of the beam in the compression face some 6 to 24 ins. distant from the support. Either this represented a point in the length of the beam where the waves of vibration coincided to produce this crack, or else it may be explained by the inertia of the ends of the beam, which thereby acted to hold the ends while the center was deflecting. In other words, the beams acted to some degree as beams with fixed ends.

The diagrams obtained from impact tests are shown in Figs. 7, 8, 9 and 10.

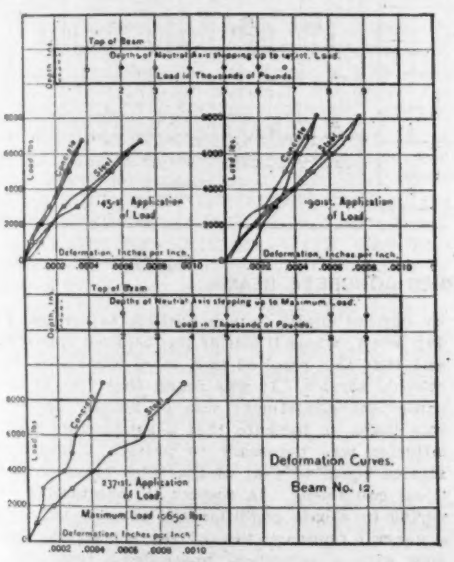


Fig. 5.

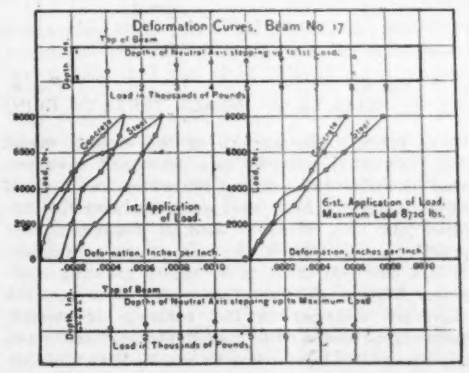
Deformation Curves. Beam No 17
1st. Application of Load.
6-1st. Application of Load. Maximum Load 8730 lbs.
Deformation, inches per inch.

Fig. 6.

FIGS. 5 AND 6. COMPARATIVE LOAD-DEFLECTION CURVES BEFORE AND AFTER REPEATED LOADINGS.

[A note from Prof. Hatt received a short time ago gives the observations made since the end of May on the beams tested under constant load. These include measurements of deflection on June 15 and Sept. 18, and a measurement of permanent set (at zero load) on Sept. 23, 1907. On the latter date the beams had been under load for something over five months. We have appended the figures to Table IV. in proper order.—Ed.]

TABLE I.—DEFLECTION OF REINFORCED-CONCRETE BEAMS UNDER REPEATED LOADING.
Deflections and set in inches.

| Approximate stress in steel. | Load, Lbs. | Beam No. 12. Number of times applied. | Deflection. | Set. | Beam No. 15. Times applied. | Deflection. | Set. | Under constant load for two months. | No 18. Ordinary testing machine load. |
|---|---|---|---|---|---|---|---|---|---|
| 3,000 | 2,400 | 1 | .025 | .005 | 1 | .025 | .... | 0.100 | .030 |
| | | 700 | .035 | .005 | ... | .... | .... | ..... | .... |
| 8,000 | 5,200 | 1 | .070 | .010 | 1 | .070 | .010 | 0.160 | .08 |
| | | 500 | .170 | .060 | 500 | .140 | .050 | ..... | .... |
| 16,000 | 6,750 | 1 | .210 | .060 | 1 | .180 | .060 | 0.290 | 0.14 |
| | | 700 | .260 | .100 | 450 | .240 | .080 | ..... | .... |
| 29,700 | 8,100 | 1 | .300 | .100 | 1 | .270 | .090 | 0.360 | 0.21 |
| | | 470 | .310 | .120 | 620 | .290 | .... | ..... | .... |

TABLE II.—COMPARISON OF MAXIMUM LOADS OF REINFORCED-CONCRETE BEAMS UNDER SINGLE AND REPEATED LOADING.

| Beam No. | Reinforcement. Per cent. | Kind of bars. | Span, feet. | Loading. Times. | Loading. Load. | Maximum load. |
|---|---|---|---|---|---|---|
| 1907. | | | | | | |
| 18 ..... | 1 | Round. | 9 | Continuous. | ..... | 9,800 |
| 15 ..... | 1 | " | 9 | 500 | 5,200 | ..... |
| | | | | 450 | 6,750 | ..... |
| | | | | 620 | 8,100 | 9,550 |
| 16 ..... | 1 | " | 9 | 60 | 8,100 | 9,675 |
| 17 ..... | 1 | " | 9 | 60 | 8,100 | 8,720 |
| 19 ..... | 1 | " | 9 | 169 | 6,230 | 9,300 |
| 12 ..... | 1 | " | 9 | 700 | 2,400 | ..... |
| | | | | 500 | 5,200 | ..... |
| | | | | 700 | 6,750 | ..... |
| | | | | 470 | 8,100 | 10,650 |
| 15 ..... | ... | " | 9 | 500 | 5,200 | ..... |
| | | | | 450 | 6,750 | ..... |
| | | | | 620 | 8,100 | 9,550 |
| 1906. | | | | | | |
| 9, 11... | 1.5 | " | 8 | Continuous. | ..... | 24,600 |
| 12 ..... | 1.5 | " | 8 | 1,776 | ..... | 25,000 |
| 2, 7, 10. | 1.5 | " | 12 | Continuous. | ..... | 15,970 |
| 8 ..... | 1.5 | " | 12 | 611 | ..... | 15,850 |
| 3, 4.... | 0.75 | Corrug'd. | 12 | Continuous. | ..... | 15,600 |
| 6 ..... | 0.75 | " | 12 | 1,248 | ..... | 15,900 |

TABLE III.—REINFORCED BEAMS UNDER IMPACT.

Beams, 8 × 8 ins. × 7 ft. Span, 6 ft. Rein. = 1.0% Steel.

a.—Increasing height of drop.

Weight of hammer, 250 lbs. Test under increasing height of fall, increment 2 ins.

| Beam No. | At elastic limit—Height of drop, ins. | At elastic limit—Deflection, ins. | At failure—Height of drop. ins. |
|---|---|---|---|
| 2..... | 12.25 | .25 | 16 |
| 3..... | 9.20 | .20 | 11 |
| 4..... | 11.25 | .25 | 14 |
| 5..... | 14.25 | .25 | 16 |

b.—Constant height of drop.

Weight of hammer, 100 lbs. Drop, 10 ins.

| Beam No. | Average deflection per blow, ins. | Number of blows at failure. | Age in days. |
|---|---|---|---|
| 6 ..... | .070 | 40 | 124 |
| 7 ..... | .065 | 55 | 131 |
| 8 ..... | .070 | 65 | 133 |
| 9 ..... | .073 | 76 | 151 |
| 10 ..... | .075 | 112 | 153 |

TABLE IV.—DEFLECTIONS OF BEAMS UNDER CONSTANT LOAD.

Calculated Stress in Steel, Lbs. per Sq. In.

| | 3,000 | | 8,000 | | 16,000 | | 29,700 | |
|---|---|---|---|---|---|---|---|---|
| Beam No..... | 22 | 23 | 28 | 21 | 24 | 25 | 28 | 27 |
| April 11..... | .04 | .04 | .10 | .10 | .15 | .14 | .20 | .20 |
| " 12..... | .04 | .04 | .10 | .10 | .15 | .15 | .21 | .20 |
| " 13..... | .04 | .04 | .10 | .11 | .15 | .15 | .21 | .20 |
| " 15..... | .04 | .04 | .10 | .11 | .15 | .15 | .21 | .21 |
| " 16..... | .04 | .04 | .10 | .11 | .15 | .16 | .21 | .21 |
| " 17..... | .04 | .04 | .11 | .11 | .16 | .17 | .21 | .21 |
| " 18..... | .04 | .05 | .11 | .11 | .17 | .17 | .23 | .22 |
| " 19..... | .05 | .05 | .11 | .11 | .17 | .18 | .23 | .23 |
| " 20..... | .05 | .05 | .11 | .11 | .17 | .18 | .23 | .23 |
| " 22..... | .05 | .06 | .11 | .11 | .18 | .19 | .23 | .23 |
| " 23..... | .05 | .07 | .11 | .11 | .20 | .20 | .25 | .24 |
| " 24..... | .05 | .07 | .13 | .13 | .21 | .21 | .28 | .28 |
| " 25..... | .06 | .07 | .13 | .13 | .22 | .21 | .30 | .33 |
| " 26..... | .07 | .07 | .13 | .13 | .22 | .21 | .30 | .33 |
| " 27..... | .07 | .07 | .13 | .13 | .22 | .22 | .30 | .33 |
| " 29..... | .08 | .07 | .13 | .13 | .22 | .22 | .31 | .35 |
| " 30..... | .08 | .07 | .13 | .13 | .22 | .22 | .31 | .35 |
| May 1..... | .08 | .07 | .13 | .11 | .23 | .24 | .31 | .35 |
| " 2..... | .08 | .07 | .13 | .11 | .23 | .25 | .31 | .35 |
| " 3..... | .08 | .07 | .13 | .11 | .23 | .25 | .31 | .35 |
| " 4..... | .08 | .07 | .13 | .11 | .23 | .25 | .31 | .35 |
| " 6..... | .08 | .07 | .14 | .11 | .23 | .25 | .31 | .35 |
| " 7..... | .08 | .07 | .14 | .11 | .23 | .25 | .31 | .35 |
| " 8..... | .08 | .07 | .14 | .11 | .23 | .25 | .31 | .35 |
| " 9..... | .08 | .07 | .14 | .11 | .23 | .25 | .31 | .35 |
| " 10..... | .08 | .07 | .14 | .11 | .23 | .25 | .32 | .35 |
| " 11..... | .08 | .07 | .14 | .11 | .23 | .25 | .32 | .35 |
| " 13..... | .09 | .09 | .16 | .12 | .24 | .27 | .32 | .35 |
| " 14..... | .09 | .09 | .16 | .12 | .24 | .27 | .32 | .35 |
| " 15..... | .09 | .09 | .16 | .12 | .24 | .27 | .33 | .35 |
| " 16..... | .09 | .09 | .16 | .13 | .24 | .27 | .33 | .35 |
| " 20..... | .09 | .10 | .17 | .14 | .25 | .28 | .33 | .37 |
| " 21..... | .10 | .10 | .18 | .15 | .25 | .28 | .33 | .37 |
| " 22..... | .10 | .10 | .18 | .15 | .25 | .28 | .33 | .37 |
| " 23..... | .10 | .10 | .18 | .15 | .25 | .28 | .33 | .37 |
| " 24..... | .10 | .10 | .18 | .15 | .27 | .30 | .34 | .38 |
| " 25..... | .10 | .10 | .18 | .15 | .27 | .31 | .34 | .38 |
| " 27..... | .13 | .10 | .18 | .16 | .25 | .70 | .35 | .38 |
| " 28..... | .10 | .10 | .17 | .16 | [.50] | [.97] | .35 | .38 |
| June 15..... | .12 | .11 | .19 | .16 | [.52] | [1.03] | 0.37 | 0.40 |
| Sept. 18..... | .12 | — | .25 | .18 | [.62] | [1.18] | 0.48 | 0.49 |
| Set measurement Sept. 23..... | .05 | — | .11 | .15 | [.53] | [1.05] | 0.34 | 0.39 |

Note: Beams 24 and 25 were overloaded by accident after May 27.

Note: On Sept. 23 the beams were relieved of their load and the set measured, these figures being recorded in the last line of the table.

## CONVENTION OF THE AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.

The second annual convention of the American Street & Interurban Railway Association was held at Atlantic City from Oct. 14 to 18. This association is the development of the various street railway associations which have been in existence for many years, and consists of a main or parent body with the title given above and three subsidiary societies of men specializing in the various branches of street railway work, known respectively as the American Street and Interurban Railway Accountants Association, the A. S. & I. R. Engineering Association, and the A. S. & I. R. Claim Agents' Association. There is in addition an affiliated body composed of the supply men known as the A. S. & I. R. Manufacturers' Association. The main body is concerned entirely with the broad matters of management and policy; each of the three specializing branches take up the work of their own particular interest and the manufacturers' society provides the entertainments and exhibits of various railway appliances, which add much to the interest of the conventions. The Atlantic convention this year is the second held by the affiliated bodies, the joint system having been adopted in Philadelphia in 1905 and the first joint meeting held in Columbus in 1906. Naturally last year the scheme of meetings had not been brought to perfection and there was some little confusion in their arrangement. This year, however, a carefully arranged schedule was adhered to with no crossing of meetings. On Monday and Tuesday the specialist associations each held meetings in separate halls; on Wednesday, Thursday and Friday the parent body held meetings in the morning and the smaller associations in the afternoon. Thus members of the subsidiary bodies could attend the sessions of the main association's without conflict with the work of their own.

Mr. John T. Beggs (President of the United Railways of St. Louis and the Milwaukee Electric Railway and Light Co.) is President of the main association, and in this capacity addressed the opening session of each of the affiliated bodies. In addition to specific advice to each body upon the subjects toward which the particular activities of that body are directed, Mr. Beggs devoted most of each of his addresses to a consideration of the present governmental attitude toward the public utilities which has been of late displayed in federal, state and municipal circles, an attitude which has manifested itself principally in official investigation of the manner of conducting the affairs of those companies which depend for their existence upon the patronage of the general public and whose affairs, therefore, to a certain degree, should be open to the investigation of the people. Mr. Beggs, somewhat more fortunate than a number of his business brethren, has just emerged, vindicated and triumphant, from an inquiry by an adversely inclined investigating committee appointed by the state of Wisconsin to enquire into certain conditions existing in the street railway systems of Milwaukee. He was, therefore, by virtue of the proved rectitude of his company, somewhat indignant at the tendency, now evident in nearly every state of the union, to consider every public service corporation licensed robber endeavoring to furnish as little benefit for as great a profit on the invested capital as the people, in their carelessness as to public administration, would allow. He held that, in spite of the fact that this is in general a false idea, its very prevalence makes it necessary that every utility should be operated in such manner as to leave not even the shadow of a suspicion of a lack of intelligent administration.

In addition to these general remarks, Mr. Beggs reminded the Engineering Association of the importance of a standardization in its work, not on account of the technical benefits derived thereby, benefits which the engineers themselves discussed later, but on account of the immense lowering in administrative costs and consequent increase in profits which the adoption of uniform rules and standards would entail.

### ENGINEERING PAPERS.

The meetings of the Engineering Association were marked by a greater interest and by better work than has been noticed in any of the previous years. The growth of the electric street and interurban railway has developed innumerable problems the solution for which has been of such immediate need that each engineer has applied his own remedy without regard to the practice or desires of the rest of the profession. It is a common fault of a rapidly growing business. Within the last few years, however, the engineers engaged in the running of electric railways as well as the manufacturers who make the equipment have come to realize that a standardization of machinery and practice is absolutely necessary for economical maintenance. Five years ago these engineers organized themselves into a body for that purpose and in 1905 joined the general association. Throughout this time the work toward standardization has been going on, but in view of the enormous variance in equipment in use in the different roads and often on the same road, the process has been a slow one. There was no precedent to follow in the electric operation standardization. Such work had to be built up from the knowledge and experience of the engineers. On the other hand, the great increase in size of rolling stock and weight of track has brought the street and interurban practice in these lines very close to that of the steam railways. In consequence, in most car and track work the standards toward which this association works are the standards adopted by the Maintenance of Way and Master Car Builders' Associations of the steam railways.

A great part of the present meeting was, therefore, taken up with the reports of the various committees on standardization, and throughout the convention the prevailing tone of all remarks was the recognition of the necessity and advantage of such action.

MAINTENANCE AND INSPECTION OF ELECTRICAL EQUIPMENT.—This committee undertook a canvas of the electric railway field to learn the good and bad practices so that recommendations for further improvement might be made. Maintenance and inspection of car equipment is of such importance in economy and reliability of operation that the overhaul period should be carefully fixed. Too many inspections are a needless expense; too few mean many failures. This committee sought to ascertain those parts of equipment requiring more frequent attention, that these might be improved until they were no longer the first to need attention.

A thorough overhaul of all controller apparatus parts was recommended for every 60,000 mi. of service. The returns of the committee's canvas indicated that overhaul of air compressors, on cars having air-brake equipment, could be best limited to intervals of not over 50,000 mi. and 1,000 mi. between inspections.

It was shown that only some 55% of apparatus inspections were made in the daytime and careful consideration was urged for eliminating night inspections. It was found on many lines that by careful study, it was possible to arrange for day work, where it was at first believed impossible and that this resulted in a more economical and reliable service. It was found that 75% of first equipment adjustment was of brakes, and this was taken to indicate that a satisfactory slack-adjuster was necessary to provide a length of service equal to that of the later types of electrical equipment. In respect to maintaining car wiring in a safe condition the answers indicated a general tendency toward the use of iron conduit with a periodical break-down test. Need for improvement was found in the trolley apparatus to increase life and decrease necessary attention. Automatic lubricators, better bushings and better contact springs were found beneficial.

The tendency to operate motors at higher temperatures has brought attention to the need of proper repairs with insulating materials suitable for the higher temperatures. This committee believed that proper attention had not been given by operating men to motor temperatures. If the motors did not melt their soldered parts or burn their insulation the average foreman seemed to pay no attention. It was held that when a higher temperature than normal was found more attention should be paid to locating the trouble. For insulation repairs of armature and field coils, wound with round wire, where the ultimate rise is less than 65° C., cotton-covered and varnished cambric was found sufficient. For a rise of 65° to 100° C., asbestos cov-

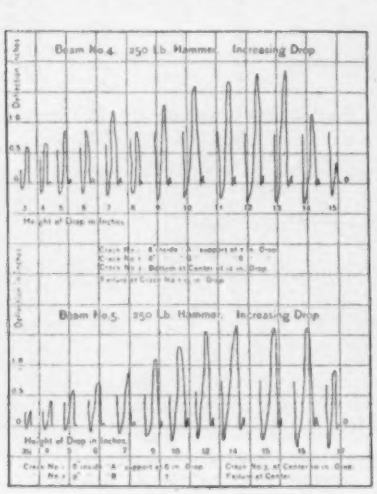
Beam No. 4. 250 Lb. Hammer. Increasing Drop.
Beam No. 5. 250 Lb. Hammer. Increasing Drop.
Deflections in Inches.
Height of Drop in Inches.

Fig. 7.

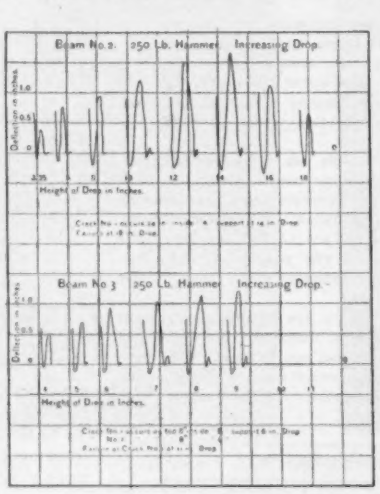
Beam No. 2. 250 Lb. Hammer. Increasing Drop.
Beam No. 3. 250 Lb. Hammer. Increasing Drop.
Deflections in Inches.
Height of Drop in Inches.

Fig. 8.

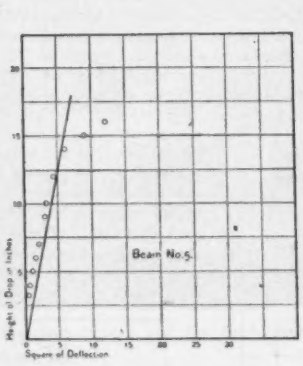


Fig. 9.

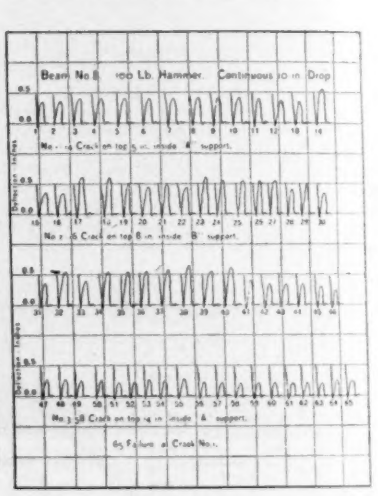


Fig. 10.

FIGS. 7 TO 10. DIAGRAMS OF RESULTS OF IMPACT TESTS OF REINFORCED CONCRETE BEAMS.

ering was found necessary. Attention was directed to the importance of impregnating all asbestos insulation with moisture-repelling varnish.

Assuming proper inspection and a minimum abuse of equipment further troubles were manifest, especially at the motor. About 42% of these were attributed to fast feeding of controllers. The use of automatic devices to limit the maximum current to the motor was recommended together with a thorough and persistent educational campaign, to acquaint the motormen with proper acceleration and the benefits that result.

RECENT IMPROVEMENTS IN CONTROL APPARATUS.—In place of a committee report on this subject as scheduled, Mr. F. E. Case, Railway Equipment Department, General Electric Co., Schenectady, N. Y., presented a paper describing some new pieces of apparatus brought out within a year by this concern. This paper was devoted largely to the new controllers in the "K-type" series-parallel, and the "M-type" of multiple-unit control. In the "K-type" a new line of three sizes has been devoloped which may be used with peak voltages up to 750 because of improved magnetic blowouts. These sizes and ratings are: "K-34" for two 150-HP. or four 75-HP. motors, "K-35" for two 100-HP. or four 50-HP. motors or less, "K-36" for two motors of 60 HP. or less. The first two sizes provide bridge connections by which field current is maintained in all motors, during the transition from series to parallel. With such provision, car acceleration has been found much smoother than when the circuit was momentarily opened or when one motor was shunted. Provision for bridge connections was not made on the "K-36" type as it was considered less essential on small equipment than the requirement for reduced space. The changes in the "M-type" have been such as to economize space, reduce the number of parts and to simplify mechanism and wiring.

CAR WIRING.—This report of the committee on this subject stated that several changes, proposed in the rules of the code of the Underwriters' National Electrical Association, were considered by the committee with the result that several modifications in the proposed changes were recommended and subsequently adopted by the Underwriters' Association and appeared in the 1907 edition of the "National Electrical Code" in the form advised.

A YEAR'S EXPERIENCE WITH GAS ENGINES.—Mr. Paul Winsor, Chief Engineer of Motive Power and Rolling Stock, Boston Elevated Railway Co., Boston, Mass., described the results of a year's operation of one of the two gas-engine plans installed for generating direct current feed into circuits in multiple with steam driven apparatus. The following excerpts from this paper will indicate some of the most important points brought out:

The Somerville Power Station has the following equipment:

One pair Loomis-Pettibone gas producers with the usual auxiliaries; two 600-B. HP. Crossley gas-engines, each 2-cylinder, 4-cycle; two 350-KW. Crocker-Wheeler direct-current generators.

This plant was started in May, 1906, and since then has given continuous, reliable and satisfactory service. There have been no shut-downs, no accidents and no failures. The fuel has been soft coal, the same as used in our steam stations, mostly run-of-mine Pocahontas. The accompanying table shows results from this actual operation, and includes all fuel used for power, heating, etc., and the auditor's usual 1% to make his books balance.

This plant can be put into service any time in less than five minutes—much quicker than can our steam plants. It can carry good loads and do it continuously. Each unit has carried 450 KW. (652 B. HP.) for an hour, with swings to 495 KW. (717 B. HP.).

For the first seven months of this year this plant used 2.034 lbs. coal per KW.-hr., while our steam plants averaged 3.477 lbs. per KW.-hr.—a saving of 41.5%. One of our smaller steam plants, containing three 200-KW. compound condensing engines, used 4.414 lbs. per KW.-hr.; this gas station used only 46.1% as much.

Personally, I believe that a gas-engine plant, making its own producer gas, will operate at least as reliably as a steam plant and will use from 30 to 60% less fuel, depending somewhat on the size of the gas plant, but principally on the size of the steam plant. The drawbacks to the gas plant are, in my mind:

(1) Cost, approximating $200 per KW. when rated so as to have a 33⅓% overload capacity.

(2) Small size of units—the largest gas-engine now built being only of about 3,000-KW. capacity.

STEAM TURBINE PAPERS.—Mr. St. John Chilton, Engineer, Allis-Chalmers Co., Milwaukee, Wis., presented a paper on some practical aspects of the construction of the Parsons type, especially in regard to peripheral velocities, clearances and leakages, end-thrust balance and facilities for repairs.

In the paper of Mr. August Kruesi, Engineer, General Electric Co., Schenectady, N. Y., attention was directed to the behavior of some of the newer apparatus, called into existence by the turbine, such as superheaters, piping for superheated steam and special condensers. It was stated that with the increased use of superheated steam, cast iron fittings had not been found elastic enough. Steel parts and tubes had been found particularly advisable in electric railway power stations on account of the variable loads and consequent change of temperatures in all superheated steam apparatus.

The author maintained that the practical limit of perfection in the production of power from steam was being approached and that present and future advances were to be secured by care in the small economies and with high pressure and superheat. It was stated that the cost of a steam turbine plant to operate on 200 lbs. with superheat was not materially greater than for 150 lbs. without superheat while the gain (something like 6% with 200 lbs. and 100°) in economy and capacity was worth working for.

An interesting phase of regulation was shown in the following excerpt:

The very considerable kinetic energy of these turbines and generators (far exceeding that of the fly-wheel and generator of engine driven sets of the same capacity) contributes very largely to their responsiveness to extraordinary fluctuations of load and to their close speed regulation. As an example, the 3,500-KW., 750-R.P.M., 13,200-volt set has a total fly-wheel effect, $WR^2$, of approximately 320,000, and this represents at rated speed a stored energy of 30,600,000 ft.-lbs., by virtue of which the machine when working at any load can carry an additional load equal to the full rating for about 0.75 of a second with a drop in speed of 3% and without additional steam, or a momentary increase in load of half the rating for 1.5 seconds thus affording the governor plenty of time in which to act even if it were for any reason sluggish.

Mr. J. R. Bibbins, of the Westinghouse Machine Co., East Pittsburg, Pa., in an extensive paper, showed the construction of a novel power plant built for the Fort Wayne and Wabash Valley Traction Company at Fort Wayne, Ind. This plant was built to carry a combined load of railway power and of lighting and stationary power. The finer economies involving considerable added investment were neglected and all "frills" were omitted. One-half of the generating apparatus was laid out for 60 cycles and one-half for 25. The building is a two-story structure with the boiler room on the ground floor. The turbines were supported directly over the boilers on structural steel foundations. This resulted in short and simple pipe runs. Barometric condensers, two to each turbine, without dry vacuum pumps, are also located under the turbines.

As this station was designed along quite novel lines an adequate consideration of Mr. Bibbin's paper is deferred until a later issue of this journal.

CARE OF ELECTRIC RAILWAY TRACK.—Mr. George L. Wilson (Twin City Rapid Transit Co., Minneapolis, Minn.) read a paper on the "Care of Electric Railway Tracks" that received considerable attention and discussion by the meeting. Mr. Wilson said that the present street and interurban railway track was a gradual development from the days of horse car traction, so that in many cases the changes have been so slow and so few that the track itself, in its ballasting and foundations, quite as often resembles its primitive original as it approaches the ideal in the modern heavy steam track. In addition to the necessity for a permanent and stable track it should be remembered that an interurban line has for its primary purpose the carrying of passengers and to add to the revenues of the road the right-of-way must be made attractive to the same degree that the track must be made stable. A certain number of people will always have to ride on a road, but its carrying ability will increase with the attractiveness of its surroundings. To this end objectionable advertising must be removed from the side of the tracks to as great an extent as possible, weeds and grass must be removed from the line, dust must be laid and the waiting places or stations beautified. It will be found that money expended in such manner will earn its fair reward.

The question of street cleaning along city tracks was taken up through letters to many railways throughout the country. It was found that in over 90% of the replies received, the city undertakes the sole responsibility for all street cleaning on streets occupied by railways. In some towns, however, the railways pay a proportional amount of this expense, it being looked upon as a part of the amount paid by way of taxation. The matter of street sprinkling by either oil or water tank cars was also looked into but it was found that very few companies are engaged in this practise. The sprinkling of roads by oil to lay dust is having an increasing use and several memoranda are appended to Mr. Wilson's paper showing costs and results from such procedure. These costs run about $100 a mile for oil sprinkled about twice a season, with excellent results in laying dust. An attempt was made to gather snow-removal statistics, but the great variation in snow fall in different climates made the costs so widely divergent as to be of little value.

In Mr. Wilson's paper and in the discussion that followed the present state of the unskilled labor situation in track work was shown to be of greatest importance. Owing to the fact that contractors and the city pay slightly larger wages than do the railways, the maintenance engineer is forced to construct and repair all of his work with the very lowest class of foreign labor, who are not at all loyal to the road, take no interest in their work and desert at the slightest provocation. The only remedy seems to lie in higher wages and longer jobs; trusting to these measures to develop a fidelity and loyalty in the men which will keep them to the work in spite of occasional offers of seemingly better opportunity.

RAIL CORRUGATION.—In an endeavor to ascertain the causes which bring about corrugation on street and interurban car rails, a committee sent to the various members of the association a list of questions, the answers to which have been collected to form a report. It must be said that very little uniformity can be noted in these answers. All sorts of rails have been affected, the length of the rail on which the corrugations have appeared varies from three to several hundred feet, the length of time in service before the trouble appears from four months to 13 years, the length of corrugation from one to fifteen inches, the depth up to as great as 3/16 in. The conditions as to curves, braking, double or single trucks, are all variable as to the effects produced. The Philadelphia Rapid Transit Co. seems to have interested itself more than any other road in this matter and its report gives the following very good resumé of their conclusions:

RESULTS OF GAS-ENGINE POWER STATION OPERATION.

Somerville Power Station, Boston Elevated Railway Company Power, Date, January, 1907, to August, 1907.

| | Jan. | Feb. | March. | April. | May. | June. | July. | Total. | Average. |
|---|---|---|---|---|---|---|---|---|---|
| KW.-hr. generated | 204,080 | 175,200 | 192,250 | 202,870 | 118,640 | 35,770 | 60,170 | 988,980 | ..... |
| Total lb. coal, including coke. | 391,223 | 364,817 | 405,050 | 401,150 | 234,705 | 90,991 | 124,452 | 2,012,388 | ..... |
| Lb. coal per KW.-hr. | 1.917 | 2.081 | 2.120 | 1.975 | 1.979 | 2.542 | 2.065 | ..... | 2.034 |
| Lb. coal per B. HP.-hr. | 1.322 | 1.436 | 1.426 | 1.363 | 1.365 | 1.755 | 1.425 | ..... | 1.404 |
| Sta. load factor based on 16 hrs. per day and 7 days per week | 58.8% | 55.9% | 55.3% | 60.4% | 34.2% | 10.6% | 17.3% | ..... | 41.6% |
| Eng. load factor | 84.2% | 86.0% | 87.4% | 82.3% | 78.3% | 73.3% | 82.8% | ..... | 83.3% |
| Gen. load factor | 99.3% | 101.3% | 103.0% | 97.1% | 92.4% | 86.5% | 97.7% | ..... | 98.35% |

The primary cause of corrugations in street car rails, it is assumed here, is vibration, either in the rails or in the entire track structure; that is, the wheels of motor or other power-driven cars have a tendency to skid or slip because of the rapid vibration of the rails, which, by reason of the inertia of the car, the wheels are unable to follow instantaneously, thereby causing friction between the wheels and rail to vary in accordance with the wave length of vibration.

The corrugations may arise from any one of four different causes: namely, the vibration or lateral bending of the web of the rail itself; the rails being loose on their supports; the ties being loose on their foundations; the vibration or movement of the foundation immediately under the track structure. Which one of these defects or conditions caused the corrugations can be ascertained by inspection of the head of the rail. Each condition produces corrugations of a different character, not only in length and form, but also with certain other peculiarities difficult of explanation without referring to a case in point.

It has been asked why these corrugations do not appear more frequently on steam roads, if they are due to vibration. The answer is that the comparatively loose rail is forced ahead by the great weight of the locomotive in the well-known long wave, and that there is very little slipping in the wheels of the trailer cars. It has been noted on foreign roads that in the most serious cases the rails were supported by chairs or were provided with some form of a cushion. A careful inspection should show that there is a slight movement between the rail and its supports.

On some street car tracks where the rails were extremely loose there have been apparently no corrugations. It has been found, however, that in many cases the corrugations actually existed, but in such elongated form as not to be apparent from casual inspection. However, a rail flexible enough to produce only these long corrugations would bring other troubles quite as serious, and it would be practically impossible to maintain such a track in any heavily traveled paved street.

The company has made quite a number of experiments and trials to verify this theory, and would call attention to one case. About five years ago it was proposed to reconstruct a section of double track about 2,000 ft. in length, using a 90-lb. 9-in. girder rail laid on ties on a gravel base. When the excavation was made, however, the earth was found to be very spongy, consisting of clay and water-bearing gravel. For this reason the excavation was carried about 7 ins. below the ties, and the space filled with concrete to a point one inch below the grade of the bottom of the ties. The ties were then carefully tamped with a mixture of fine concrete and the space between them filled to the base of the rail which was also tamped. An additional 2 ins. of concrete was then placed as a foundation for the paving.

After a year's service the rails of both tracks were found to be badly corrugated over practically their entire length, the corrugations being 1 to 1.5 ins. apart, and extending from the gage line over about two-thirds the width of the head. In order to ascertain the cause of this trouble, the paving and the concrete were removed above the ties, both in and outside the rails, and a careful inspection was made and measurements taken to ascertain if there were any vertical movement in the roadbed or rails, but none could be detected. It was thus evident that if the theory was correct, there must be a lateral bending or vibration of the rail itself, and in order to ascertain if this were a fact an instrument was constructed. The frame may be rigidly clamped to the base of the rail, and a vertical arm is provided with a piston carrying a nut. The piston may be forced against the head of the rail by a spring behind the nut. The upper end of a hand or pointer engages the nut, the other end resting on a graduated arc. The lengths of the upper and lower arms of the hand or pointer are in the ratio of 10 to 1, each graduation representing 1-64-in.

In using this machine it is only necessary to clamp it to the base of the rail and set the lower end of the hand at zero, which can be done by turning the piston in the nut. The amount of the lateral motion in the head of the rail, due to bending or buckling of the web, will then be indicated by a marker which is placed against the hand before a car is allowed to run over the rail. In many cases a movement of 3-32-in. has been noted.

In order to further verify the results of this experiment fish plates 30 ft. in length were secured and bolted to the outside of the rail, thus giving a support to the head and greatly stiffening the entire rail. After a few months it was found that on rails equipped with these fish plates corrugations were rapidly disappearing. As strengthening the rail in this matter would be too expensive to be practical, it was decided to stiffen the web of the rails by using a special brace on each alternate tie along the outside of the rails. This work was completed a little over a year ago, and a recent inspection shows that nearly all of the corrugations have disappeared.

It has been noted by some roads that corrugations were appearing on rails laid on a concrete base, but in every case that has come to the notice of the writer the rails had been temporarily supported by wooden ties, concrete being tamped under the base of the rail between the ties with no provision made for taking up the shrinkage, which always takes place during the settling and drying of the concrete.

In many cases where track is constructed in this manner the rails seldom have a continuous or uniform support, by reason of their not having anchorages or holding-down devices other than spikes in the ties, spaced at long intervals. This results in a slight movement of the rail on its foundation, and soon causes corrugations to appear, although quite frequently where light rail is used the trouble comes from the bending or buckling of the web of the rail, as noted above.

It is believed that in concrete roadbed construction, it is absolutely necessary to provide some means of drawing the rail down on its bed, thereby taking up the shrinkage and preventing any liability of the rail moving on its foundation. In this class of construction, vibration can be prevented only by providing a rail of the proper design and an absolutely uniform and continuous support.

When the trouble in tie construction is found to have been caused by loose rails or ties, the only remedy is to grind or file the head of the rails, and to immediately follow this work by firmly securing the rails to the ties and by tamping, using a coarse gravel wherever the foundation is found to consist of soft or spongy material.

Corrugations in light rails, due to the bending of the thin web, are difficult to remedy without considerable expense, but after the heads have been filed to a comparatively smooth surface, it has been found that setting the track to a slightly wide gage will sometimes prevent a recurrence of the defect.

It is very difficult to grind off the summits of corrugations without a specially constructed machine mounted on a truck, and practically impossible with the usually portable grinding equipment, consisting of an emery wheel connected to a motor by a flexible shaft, because when the eye approaches the rail closely enough to permit the operator to manipulate the wheel the corrugations apparently disappear. In nearly all cases filing is probably the best method. The file should be mounted in a heavy cast-iron holder having guiding lugs bearing along the gage line of the rail and equipped with long handles at each end, so as to permit of operation by two men from a standing position. To prevent the possibility of trouble from bending of the webs of the rails, the company about two years ago had the web of its heavy rail increased to a thickness of 9-16-in. In support of the theory which is here advanced, it should be added that on a system of about 600 miles the amount of corrugated rail has been reduced to a very small percentage. The price of immunity from this trouble, however, is eternal vigilance, and it might also be added, the expenditure of considerable money in maintenance when any form of wooden support is used.

In contrast to the above noted theory as to the cause of corrugation, Mr. C. B. Voynow (Philadelphia) advanced the theory that the trouble was more liable to occur on firmly held track, in which case the upper layer of the rail is caused to flow in the direction of the traffic; as the under part is tied to a solid base and not able to move ridges or humps are set up on the upper face. He found that after the humps or ripples were filed away there was no recurrence of the trouble, due, perhaps, to the hardening of the metal under pressure.

STANDARDIZATION REPORTS.—Although it consists largely of detail matters of design, the report of the Standardization Committee was probably the most important and, judging from the attendance, the most interesting of the papers presented before the Engineering Association. The engineering of street railways is still in its youth, and like all youthful things, it has been in a constant state of change. The equipment has been added to with the needs of the business and as the science has been steadily progressing, every new thing bought has been a slight change and improvement over its older fellows. The result has been that every road has had in stock all varieties of equipment, in detail and in gross; the only thing that has remained the same has been the gage. The time has now come when the Engineering Association, as the proper body for the duty, has felt called upon to adopt certain standards of construction. Not as enforced obligations upon any company, but as the recommended best practise which each road should tend toward so that in the course of a few years the entire structural portions of the road may be uniform. In this work, the committee appointed for the purpose had the full co-operation of all the companies making the apparatus so that the standards agreed upon will be satisfactory to all concerned.

The report this year, submitted by the committee and adopted, covers axles, journals, journal bearings and boxes, brake shoes, brake shoe heads and keys, section of tread and flange of wheel and rails. The standards adopted agree very largely with the best practise now in vogue and it should be noted tend toward the standards now in use by the Master Car Builders on steam railways.

Four general types of axles were adopted: 4½-in. for motors up to 45 HP.; 5-in. for 45 to 65 HP.; 5½-in. for 65-100 HP., the two being otherwise identical in size; 6-in. for 100 to 150 HP., and 6½-in. for 150-200 HP., also of identical dimensions; and 7-in. diameter for 200-250 HP. The journals and journal boxes are standardized to fit the above axles. The brakes and brake shoes are practically M. C. B. standards. The wheels adopted are of two sizes, the smaller with a 2½-in. tread and ¾-in. depth flange, the larger of 3½-in. tread and ¾-in. depth flange. With the increasing weight of rolling stock there seems to be a growing trend toward the larger or 3½-in. tread. This is being installed in nearly all the large interurban lines.

OPEN VS. CLOSED TERMINALS FOR CAR HOUSES.—The relative advantages of open and closed terminals for car houses was taken up by a committee appointed for that purpose. It was admitted that for permanent storage, such as for closed cars in summer and open cars in winter, the covered house was absolutely necessary, but for houses for daily use in storing cars during lax hours or at night, the question depended to a large extent on circumstances. The committee accordingly designed three car houses and furnished an estimated cost of each. The costs were as follows:

| | |
|---|---|
| (a) Closed terminal | $108,000 |
| (b) Open terminal with 100 ft. of barn for repair storage and closed offices | 49,000 |
| (c) Entire open terminal | 25,000 |

Taking into account interest on the investment, maintenance and insurance, this represents an annual saving of $9,960 of (c) over (a) and $7,080 of (b) over (a). The arguments against the open yard are that the deterioration from being exposed is greater and that the amount and efficiency of the repairs will be less, owing to the reluctance of workmen to stay in the open in inclement weather. The committee therefore came to the following conclusions to guide the company in deciding this question:

(1) Mild and comfortable climates would be favorable to unprotected yards. Extreme weather would make closed terminals desirable.

(2) Inability of management to get large sums of money for investment would favor an open terminal.

(3) Anticipated change in location would require an open terminal.

(4) A large proportion of cars when out of season stored in separate storage barns leans toward unprotected terminals.

(5) The more cars housed and the less on the road the entire 24 hours favors protected trackage.

(6) If the terminal is used for storing out of service cars as well as actual operating rolling equipment it makes protected depots a necessity.

(7) If terminal is located at lay-over point or end of trips for all cars, so that they may be inspected at turning points and no repairs are made at night, this would be a point in favor of an open operating barn.

RAIL STANDARDS.—The question of rail standards was taken up both by a committee and by a paper of Mr. C. G. Reel (Kingston Consolidated Ry. Co., Kingston, N. Y.) on "The Use of T-Rails in Cities." The committee made a progress report to the Executive Committee and no definite action on it was taken by the association. The report recommends as best practise and as a standard for city construction in paved streets the use of the 7-in. T-rail known as "Lorain section, No. 95-400" or as "Pennsylvania Steel Co. section, No. 272." This rail is 7 ins. high with a 6-in. base, head 3 ins. wide and 1⅝ ins. deep, and 7/16-in. web. It weighs 95 lbs. to the yard. It is the opinion of the committee that this T-rail is altogether the best rail for all street

work, but owing to certain municipal regulations against its use, they have provided four half alloy grooved rails for cities where the T-rail is prohibited. These grooved rails are 9-in. 137 lbs.; 9-in. 122 lbs.; 7-in. 122 lbs., and 7-in. 98 lbs. Of 81 companies answering letters 29 reported municipalities prohibiting the use of T-rails, 36 reported T-rails as in use and 16 did not answer. The T-rail is allowed throughout the South and West and in some of the smaller cities in New England, where macadam streets have been laid; it is as a rule prohibited in the large cities of the East, in the Middle West and in Texas.

Mr. Reel's paper described the standard T-rail construction now in use in Kingston, N. Y., and closed with a strenuous advocacy of this rail as against the old grooved or girder shape. The entire sentiment of the railway men is in favor of the T-rail, the only opposition being among municipal engineers. Mr. Reel's paper, which will be reproduced in a later issue, should, therefore, be of interest to both sides on the question.

The Committees on "Concrete Tie Investigations" and "Operating and Storage Car House Design" reported that they had continued their work throughout the year, but had not as yet progressed enough to warrant the publication of reports.

## PAPERS OF GENERAL INTEREST.

THE TECHNICALLY TRAINED MAN AND THE ELECTRIC RAILWAY PROFESSION.—Professor H. H. Norris, Cornell University, Ithaca, N. Y., presented a paper with the above title. In this paper a definite apprentice course was outlined as a transitory training for engineering graduates entering electric railway work. This course would occupy one and a half years. The discussion of this apprentice course showed a general belief that the time was not long enough to satisfactorily train the graduates.

THE WORK OF THE NATIONAL FIRE PROTECTION ASSOCIATION IN THE ELECTRIC RAILWAY FIELD.—Mr. Ralph Sweetland, Engineer, New England Ins. Co., sketched the organization and growth of the National Fire Protection Association. Its work was described as

the preparation of standards for so-called fireproof or fire-resistive construction, slow-burning construction and correction of buildings of inferior construction, especially as regards resisting the action of fire; standards for fire doors and fire shutters and wired glass windows; standards for construction and installation of all fire fighting appliances and apparatus, such as the automatic sprinkler; steam, rotary, centrifugal or electric fire pump; hydrants, hydrant houses, hose, play pipes; chemical fire extinguishers; standards for signaling systems used for the transmission of signals affecting the fire hazard, such as thermostats, journal alarms, watchman's time-recording apparatus and automatic sprinkler alarms; standards for the construction of ash, waste and safety cans.

The shop inspection of safety devices was generally outlined and the inspection of some of the common apparatus shown by some concrete examples.

FREIGHT AND EXPRESS ON ELECTRIC RAILWAYS.—Mr. P. P. Crafts, General Manager, Iowa and Illinois Railway Co., Clinton, Ia., read a paper entitled "Light Freight Handling By Electric Lines." The growth of freight service was outlined as parallel to the growth of the modern high speed electric road and it was stated that interurban roads were now being developed with a view of handling freight as well as passenger traffic. The author made the following general statements and applied them to the service of the Iowa & Illinois Railway:

Many managers, in their anxiety to build up a profitable business, have overloaded their roads with expensive handling facilities, and freight depots, intricate accounting systems, free train deliveries, etc., which have eaten the profits that might otherwise have been realized.

Whether or not a freight business will be profitable depends somewhat upon the following conditions:

(1) The population served outside of the main terminal and its dependence upon that terminal as a trading center. (2) The proximity of other trading centers to the population served outside of the main terminal, and the railway facilities tending to attract business away from the main terminal. (3) Steam trunk line connections and the ability of interurban roads to establish joint rates with them.

Interurban freight traffic may be properly divided into the following classes:

(1) Strictly light packages, transported only in baggage rooms of passenger coaches, at express rates or at a fixed charge per package or per hundred pounds, regardless of class, and generally termed express business. (2) Less than car-load freight transported on fast baggage cars at regular freight or special tariffs under regular or special classifications, generally the former. (3) A combination of class two and the haulage of a few local car-load shipments daily at regular tariffs and classification. (4) Regular car-load freight hauled by steam or heavy electric freight locomotives at regular tariffs and classifications. Or any combination of the above-mentioned classes.

It is gratifying to the average shipper to know that the road will accommodate him when he gets caught short of some commodity, or that his profits will be increased by being able to obtain quick shipments of perishable goods. This also induces him to carry a smaller stock of staple articles, the result being that the road gets the benefit of a larger number of shipments at the minimum rate, which is in fact the most profitable part of the freight business, except in car-load lots.

Mr. H. H. Polk, President, Des Moines Interurban Ry. Co., in "Freight Service on Electric Railroads," dealt with some of the more general questions involved when an interurban road undertakes a general railroad business. The points involved were such as freight department, freight agents and solicitors, terminal freight stations and way-station freight-rooms, side tracks, rolling stock and rates. In the discussion of these papers such diverging opinions were offered regarding the profit in "electric freight" that it was evident that the advisability of such service was dependent almost wholly on local conditions. The general results seemed to have been unfavorable in the East and the reverse in the Middle West and on the Pacific slope.

PROBLEMS OF THE SMALL ELECTRIC ROAD.—Mr. H. S. Cooper, Manager, Galveston Electric Co., Galveston, Texas, in this paper passed by the usual definitions of a small road and defined it as one

whose condition is such that it will not admit a full departmental organization. It is one that, although it might rank out of the "small" class in items of gross earnings, track mileage, rolling stock or population served, yet, is so situated that it cannot be divided into the proper number of clear-cut and non-interfering departments with a competent, technically practical man at the head of each. It is such a road whose manager has to be, ex-officio, superintendent of every or of most departments.

Three problems of such a "small" road were outlined and very evident lines of solution indicated. These problems were: (1) proper organization, (2) the direct and personal relation of the company and its officers to the municipality and its patrons, (3) the use of employees and materials. The most important of these was concerning organization, as shown by the following extracts:

The importance of organization is not fully appreciated by the "small" or "near-small" road. To many owners and managers, organization into departments seems a useless and non-productive process, entailing no revenue and much unnecessary expense, time and labor. To the very small road, where the manager is everything, from engineer to bookkeeper, where the difference between bond interest and deficit is but a hairbreadth, in such a road, departmental organization seems—and probably may be—somewhat of a farce. But it must be a very small road where this really applies. Simple organization is capable of beginning much lower down in the scale of roads than is commonly practiced among owners and managers, and even a pretty full and complete organization can be started—and will prove remunerative—a great deal sooner than is generally believed.

The simplest organization will have not less than four departments—counting the manager as one of them. These would be:

1. Accounting. (Bookkeeping, Car accounting, Purchasing, Correspondence,) — Manager and clerk.
   Claim department. Accidents, &c. Manager and local counsel.
2. Generating. Power station. Chief engineer. Assistants.
3. Transportation.—Operating of cars. Inspector, or starter and trainmen.
4. Maintenance (Rolling stock, Buildings, Track, Line.) — Superintendent — (Barnmen, Barnmen, Trackmen, Linemen.)

This simplest plan of organization is possible to any road; of course, in a very small road the manager may have to be the chief engineer and the superintendent of maintenance and of transportation in addition to his other duties, but in any road having full business for six to ten regular cars on an urban line or three or four regular cars on an interurban line, the above plan of organization is none too complex.

As we go up in the scale of the smaller roads, or as a road grows in size, these departments can easily and profitably be amplified until it is—for a small road—fully organized into departments, which means into about eight, as follows:

1. Accounting and auditing.
2. Claims and legal.
3. Purchasing and stock-room.
4. Power station.
5. Shops.
6. Track.
7. Line.
8. Transportation.

And, if there is a "pleasure park" attachment,

9. Advertising and attractions.

That organization—those departments—will answer for a wide scope of sizes of roads. It may be that in the smaller roads the manager will again have to be the virtual head of each department; that the departments will overlap and interfere to some extent; but these are drawbacks only to be amended by increase in size, in earnings or in profits, and, if properly carried out, that very organization will aid to that end.

The problems of the large roads are only the problems of the smaller one condensed, intensified, made into a formula by pressure of traffic, by condensation of population, by humanity in the gross instead of in the individual. The large roads need the experience of the small one, for its problems are basic ones, worked out empirically, with travail and by retail, but containing the true principles and with those principles open and apparent.

WHERE MAINTENANCE ENDS AND DEPRECIATION BEGINS.—Mr. J. H. Neal, Auditor of Disbursements, Boston Elevated Ry. Co., Boston, Mass., treated this very troublesome subject in a broad way. The general line of thought may be best shown in a few short abstracts:

Depreciation accounting is almost entirely dependent upon estimates and uncertain elements; two features, and two only standing forth as positive factors. The first is, that values are continually diminishing in practically every creation by man, and the second that maintenance is but a partial replacement of such impairment.

Efficient management, among other qualifications, implies the ability to approximately determine the point where expense of ordinary repairs becomes abnormal, and consequent renewal or substitution necessary. On the other hand, the essence of successful accounting for depreciation lies in the degree of accuracy with which the probable life of property is determined. At a glance then it can be seen that these problems are analogous, and that the same means must be adopted for the solution of either the one or the other, both requiring the establishing of a point where maintenance should end.

A careful analysis of the accounts no doubt materially assists in forming judgment as to the economy and efficiency with which a property is being maintained. That is what they are for. Beyond question, however, something more than this is needed, for it is easy to show low maintenance cost for a period of years at the expense of the life of the property, and equally easy to unwisely expend large sums in maintaining equipment that should be discarded.

Of course it may be said that, if depreciation reserves were established, these in conjunction with maintenance accounts would render the situation complete. However, this is not at all the fact. Rather the rate of the annual charge for depreciation is often determined from accounts which involve the erroneous conditions mentioned above, with possibly others.

The seven common methods of charging depreciation are enumerated below, together with a practical illustration showing the application of a few:

1. Equal proportion annually of original cost.
2. Fixed percentage on gradually diminishing balance of original cost.
3. Fixed percentage on gross earnings.
4. Fixed percentage on net earnings.
5. Annuity system.
6. Periodic revaluation.
7. Proportion of betterments charged to operating.

None of these methods in themselves can assist in establishing the point where maintenance becomes uneconomical. In fact, they are nearly all originally based on an estimate as to where this point occurs.

One thing is certain, that with the single exception of "periodic revaluation," each is constructed upon a basis which the progress of time and events must surely change. The executive must frequently adjust the means which he adopts to conditions as they actually exist, or error and confusion will surely result.

Revaluation is in most cases impractical, at least with frequency, therefore to effect these adjustments, to establish probable life and to supply the element missing from our conventional bookkeeping accounts, continuous consideration must be given to the physical changes which take place. It is in the light of such detail only, that a proper display of the relations between maintenance and depreciation can be obtained, because of the wide divergence in the character of equipment and the governing conditions.

No department head can intelligently conduct his work without a mass of detail which furnishes exactly the information desired. The man who repairs the motors must have a knowledge of the frequency and causes of breakdowns which interrupt travel or require large expenditures. The man in charge of tracks must study the life of ties, timbers, rails, frogs, etc. The man who produces power must know when the boilers or steam piping, etc., become a menace to safety, maintained though they may be, and so right through the line, one and all are endeavoring to establish the very point at issue. None of these men are so bold, however, as to be willing to commit themselves as to what rate of depreciation would be proper, taking all kinds of track, or all kinds of motors, or all kinds of power-house equipment together. They wish to particularize. Permit them to do this, and the competent men can make exceedingly accurate estimates.

Just so with the general proposition. The pith of the matter is subdivision. Certainly it is not wise to trust to the generalization of others. Each property is a problem in itself and should be governed by matters of facts obtained mostly from its own experience.

There is no reason to fear the detail which subdivision involves. Once a list is established it only remains for the auditor to watch and adjust it in combination with department heads. Naturally some extra

time and trouble is required, but why should we expect to control so important a matter by a single table of some dozen items culled from the statements of others? The writer advocates the policy of "each road by itself, each subdivision by itself, and each changing condition by itself"; giving due consideration to the experiences of others, but adopting their details only where circumstances are determined to be exactly similar.

In the discussion of Mr. Neal's paper, Mr. W. T. McDole, Auditor, Cleveland Electric Railway Co., stated that his concern had compiled the maintenance for several years back and on this basis had charged out so much per car mile on track and equipment and a certain amount per KW.-hr output for the power stations.

THE COMMITTEE ON MUNICIPAL OWNERSHIP reported the results of a canvass of the country in respect to the sentiment toward municipal ownership of public utilities. It was pointed out that the desire for municipal ownership was greatly diminished, owing largely to a campaign of education undertaken by the service corporations. A great increase in the popular demand for the government control and regulation was shown in the replies to this committee's letters of inquiry.

In each of the non-technical branches of the association there were presented a great number of papers dealing with problems of accounting and administration. These were so voluminous as to prevent their being reported even by title.

OFFICERS.

For the ensuing year the various associations elected the following officers:

American Street and Interurban Railway Association—President, Calvin G. Goodrich (Twin City Rapid Transit Co., Minneapolis, Minn.); 1st Vice-President, James F. Shaw (Boston & Worcester Electric Co., Boston, Mass.); 2d Vice-President, Arthur W. Brady (Indiana Union Traction Co., Anderson, Ind.); 3d Vice-President, Thos. N. McCarthy (Public Service Corporation, Newark, N. J.); Sec'y and Treas., Bernard V. Swenson (29 W. 39th St., New York City).

A. S. & I. R. Engineering Association—President, F. G. Simmons (Superintendent of Construction and Maintenance of Way, Milwaukee Electric Ry. and Light Co.); Sec'y and Treas., J. W. Corning (Electrical Engineer, Boston Elevated Ry. Co.).

A. S. & I. R. Claim Agents' Association—President, H. R. Goshorn (Philadelphia Rapid Transit Co.); Sec'y and Treas., B. B. Davis (Columbus, O., Ry. & Light Co.).

A. S. & I. R. Accountants' Association—President, F. R. Henry (United Rys. Cos., St. Louis, Mo.); Sec'y and Treas., E. M. White (Birmingham, Ala., Ry., Light and Power Co.).

## ANNUAL CONVENTION OF THE AMERICAN BOILER MANUFACTURERS' ASSOCIATION: NEW LIGHT ON U. S. BOILER PLATE SPECIFICATIONS.

The nineteenth annual convention of the American Boiler Manufacturers' Association was held at Atlanta, Ga., on Oct. 8, 9 and 10.

The most interesting feature of the convention was the discussion which arose over the report of the Committee on Materials—presented verbally by Capt. T. M. Rees, of the Jas. Rees & Sons Co., of Pittsburg, in the absence of Chairman Meier—throwing, as it did, some interesting light on the controversy over the new boiler-inspection laws. Most of this discussion was contributed by Mr. W. L. Hirsch, of the American Steel & Wire Co., for the steel manufacturers; and by Capt. Rees for the boiler manufacturers.

The report had to say, in the main, that it is very difficult to obtain proper boiler plate to pass the United States boiler-inspection requirements, that all of the mills in Pittsburg have refused to make this steel but one, and that that one mill has successfully made it only within the last few weeks.

From all that Capt. Rees could learn, he understood that the steel mills had been endeavoring to make boiler plate too cheaply, and in order to do this have been using inferior scrap. One mill in a recent heat, made entirely by the acid process instead of the basic process, and by using entirely new material, did not lose one sheet in the heats that they made and have filled all of the orders outstanding on their books. The speaker had an order in one mill for over six months, and believed it to be true that the mills are trying to furnish plate cheaper than the users of the plate desire and have been trying to get out quantity instead of quality. He emphasized the fact that those who use boilers do not want a cheap or inferior quality of steel, but are willing to pay a good price for steel equal to what was formerly furnished the trade if they are allowed under the marine laws a steam pressure in accordance with the quality of steel used.

Capt. Rees stated that one mill in Pittsburg is now making, under the acid process, steel that will meet all the requirements of the United States marine law; and that he had received a wagon load of it the day before he left home. The speaker believed that if the mills that are not too badly rushed will put good material in the heats, they will be able to make a boiler plate entirely satisfactory to the boiler manufacturers, and such as has not been had for many years.

In discussing the report, Mr. Hirsch said that for 20 years his company had made contracts with the leading railroads of the United States for fire-box and boiler steel, subject to the most rigid chemical and physical requirements in specifications of any steel that they produced, not excepting that for the United States Government. In earlier days, he said, they produced crucible steel, then the only steel in existence; and added that while it is true that crucible steel is of superior quality, it is open to the objection that by reason of having to heat the metal in small pots, it is impossible to make large plates such as are demanded today, in order to reduce the number of seams that are necessary for steamboat and locomotive boilers. In Mr. Hirsch's own words:

> The steel maker is not infallible, but endeavors to comply with the best specifications, and to obtain the required chemical and physical results so long as they are within reasonable bounds.
>
> A year ago last July the United States Government asked the American Steel & Wire Co. to comply with certain specifications for marine steel, which the company declined to do because the specifications were impracticable; not because the company could not produce high-quality steel—on the contrary, it has produced fire-box and boiler steel of high quality. The impracticable specifications referred to were possibly drawn up by men who did not understand the physical and chemical qualities of steel, and who required combined physical and chemical conditions which could not be practicably produced.
>
> An association representing all of the plate-makers of the United States has frequently discussed all these conditions, and the speaker wrote to every plate-maker in the United States requesting their views as to the new specifications of the Government. A majority of those addressed replied that they would decline to consider orders under such specifications. The American Steel & Wire Co. is anxious to supply not only the boiler-makers but the United States Government with the product they require; but it cannot perform impossibilities. In this progressive age, when quantity is an urgent necessity, and when prices have been forced down from $5 to $1.70 per hundred lbs., the same quality cannot be expected. The demand for common steel products is so extensive and insistent that we are compelled to give first attention to meeting this demand.
>
> The speaker was asked by an inspector of the Pittsburg district some time ago, "Hirsch, why don't you make marine steel plate?" and answered, "Because we cannot produce it without losing money. The specifications are impracticable." Surely a concern that has prided itself on quality for 25 years would not say that it cannot produce the material if it were not impracticable.
>
> Boiler plate which contains not more than 0.04 phosphorus and not more than 0.04 of sulphur, with the tensile strength regulated entirely by carbon, is a good steel; and when steel is produced which meets under test all of the specifications and is better than anything that was ever produced before, but is rejected because it shows a difference of not more than 1% between coupons cut longitudinally and those cut transversely, such rejection is unreasonable.
>
> Steel showing 25% elongation is certainly good steel; another man may demand 26%; another 27%, and so on up to 30%, at which point the steel manufacturers must stop.

Mr. Hirsch further said in effect that, while the boiler manufacturer is right in requiring of the steel manufacturer that his product contain not more than a certain percentage of phosphorus, sulphur and silicon, the hardness or softness of steel is regulated by the percentage of [illegible] that tensile strength is not a question of [illegible] alone, but of hardness or softness. Given proper elongation and ductility, and [illegible] tensile strength, he said, and the result would be an ideal boiler steel; a tensile strength of [illegible] or 60,000 lbs., with high elongation and ductility is better for boiler steel than 65,000 or [illegible] lbs. with less ductility and low elongation.

Replying to Mr. Hirsch, Capt. Rees said that he agreed with him that if the boiler manufacturer desired good steel he should pay for it. He had never experienced any trouble with crucible steel for fire-box and locomotive-boiler use, and for the best article was willing to pay the best price; but he stated that steel made by the crucible process is now prohibited by the United States law, and that he had protested against this prohibition, and was so on record. Since the absorption of most of the plate manufacturers throughout the country by what is called the United States Steel Corporation and also the Crucible Steel Corporation, a great deal of competition in boiler plate has been cut out; but the speaker thought that the day would come when new mills would arise to compete with these corporations, and undoubtedly bring about the production of better boiler plate; with this in view, and in order to throw open the doors of competition, crucible steel for boiler plate should not be prohibited by the United States Government.

Apropos of his claim that old-time boiler plate was superior to the present-day product, Capt. Rees mentioned a case in which he had submitted physical proof before the Boiler Department at Washington, upon an occasion when a meeting of steamboat men and boiler manufacturers was called there. He took a test piece from a plate made in 1879, and placed it in comparison with a piece cut from a plate made for a steamboat owned by the American Steel & Wire Co.; this comparison was submitted to Secretary of the Navy Metcalf, with proof that the plate made in 1879 was still good, while the other had deteriorated from the heat to which it had been subjected so that it was utterly worthless.

Capt. Rees further said that neither the users nor the boiler manufacturers have approved the changes made in the marine law, which were brought about by the plate manufacturers in conjunction with the supervising inspectors—the latter having made changes in the test pieces without changing the rules to correspond therewith. For five years efforts have been made to secure a change in the rules to correspond with the change in the test pieces, so as to allow the same steam pressure that was formerly allowed.

In reply, and concluding the discussion, Mr. Hirsch made the proposition that the American Boiler Manufacturers' Association consider the matter of increasing the thickness of boiler plate and reducing its tensile strength, thus allowing the same working pressure—for the reason that it is easier to work a softer plate of a thicker gage than to work a harder plate of a thinner gage; and that the thinner a plate is made in the process of manufacture, the harder it becomes. A plate ⅜ ins. thick that will show 25% elongation in 8 ins., at a thickness of ¼ in. will show an elongation of 20%.

Officers elected for the coming year were as follows: President, M. F. Cole, Newnan, Ga.; Vice-Presidents, T. M. Rees, Pittsburg; J. Don Smith, Charleston, S. C.; W. A. Brunner, Phillipsburg, Pa.; H. D. MacKinnon, Bay City, Mich., and M. A. Ryan, Duluth. Secretary, J. D. Farasey, Cleveland; Treasurer, J. F. Wangler, St. Louis.

THE LARGEST COAL DOCK IN THE WORLD, according to a press report of Oct. 16, is to be built by the Pittsburg Coal Co., at Duluth, at an estimated cost of $1,000,000. The plans for the new dock were drawn last year, but the contract was not let on account of the condition of the coal market. The steel for the dock will be made in Pittsburg, at the mills of the United States Steel Corporation, and the dock will be situated next to the dock of that corporation at Duluth—previously the largest in the world.

# ENGINEERING NEWS

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Long mountain tunnels are conspicuous by their absence on American railways, and none of the numerous railway crossings of the Rocky Mountains present such remarkable examples of tunneling as the railways crossing the Alpine range in Europe. Indeed the longest railway tunnel in this country is in the East, being the Hoosac Tunnel on the Fitchburg Division of the Boston & Maine Ry. This is 4.25 miles in length, and was built in the early days of American engineering. The noted Alpine tunnels are from 8 to 12½ miles in length, with others 10 and 16 miles long now proposed. The three longest tunnels through the Rocky Mountains are the Cascade Tunnel, Great Northern Ry. (1890-92), 13,973 ft.; Stampede Tunnel, Northern Pacific Ry. (1886-88), 9,850 ft.; Busk Tunnel, Colorado Midland Ry. (1890-93), 9,395 ft.

Active steps are now being taken for the construction of what will be by far the longest mountain tunnel in the United States, to form a substitute for the present open route of the summit section of the Denver, Northwestern & Pacific Ry. This is a new railway under construction from Denver, Colo., to Salt Lake City, and which will be about 500 miles in length, as compared with 740 miles by the Denver & Rio Grande Ry. or 630 miles by the Union Pacific Ry. It has 28 miles of 4% grade on the line now built through the pass at Corona, the summit elevation being 11,660 ft. above sea level. In order to afford a more favorable line for operation as part of a new trunk line system, it has been decided to drive a six-mile tunnel under James Peak (about 50 miles west of Denver), with grades of 0.25% and 0.70% and having a summit elevation of 9,229 ft. The Continental Tunnel Co. has been organized as subsidiary to the railway company, the latter guaranteeing the bonds and becoming eventually the owner of the tunnel. It is expected that work will be commenced before the end of the year, and that it will be completed in three or four years.

A considerable portion of our space this week is devoted to the International Congress of Hygiene and Demography recently held in Berlin. The large number of papers presented renders it impossible to give very much space to any one of those which we have selected for mention; but the summaries given represent the ideas now held by many eminent sanitarians and other scientists, on such important questions of the day as the smoke nuisance, the prevention of dust on macadamized roads, caisson disease, various phases of the railway service, sewage and water purification, and modern methods of fighting typhoid fever, yellow fever and malaria. Although the Congress is international in scope and a number of Americans were present, practically all the papers presented, so far as has come to our attention, were by Europeans, and of these nearly all were in French or German. This was to be expected, in view of the fact that the Congress was held in Berlin. When the Congress comes to Washington, three years hence, it is to be presumed that many papers will be presented in the English language. As our special correspondent has well said in introducing his general report on the Congress, there will be a fine opportunity to organize the Washington Congress in such a way as to greatly increase its usefulness as compared with the one just held at Berlin. It is very difficult, however, to so conduct an international conference as to make it highly useful for the foreign delegates in attendance, but this will present all the greater opportunity to Americans in Washington in 1910.

Before dismissing the Congress from consideration here, a word may be said regarding some specially interesting points in a few of the papers. It is to be noted particularly that the authors of two of the papers on the general topic of combating typhoid fever laid great stress upon the necessity of some measures of protection against chronic typhoid bacillus carriers. Great stress was also laid upon the dangers of contact infection, one of the speakers going so far as to state that the danger of the spread of typhoid fever through public water supplies was secondary to the danger from personal contact. It may also be noted that in a paper on the control of malaria in Italy more importance was placed upon the administration of quinine to individuals than their protection by screening dwellings, by draining swamps and treating breeding places with oil or other chemicals. This, however, was with reference to the control of malaria throughout large areas, and as it had primary reference to Italy it must be assumed that the economic state of that country does not permit drainage and other combative measures that might be perfectly feasible in the United States.

Our repeated statements, direct and implied, that little was known—far too little—of how to design very large compression members, have met with more or less disapproval on the part of bridge engineers. The letters of Mr. F. H. Bainbridge and Mr. T. K. Thomson in this and our last issue, for example, contain expressions of this disapproval.

With all due respect to these contrary opinions, however, we believe that our statement rests on a sound basis. It may be true that here and there a bridge engineer, in designing a particular chord or post, has produced a structure able to meet all the demands which full-sized tests would reveal, and thus has embodied in a practical example the principles of proper construction of columns. But did he know how and why he put in each specific element of strength? Could he have written down a set of rules or requirements expressing the essentials of column design? We believe not. Or, if perhaps one or two such men, more careful and analytical thinkers than their brethren, could have written such a code, surely this knowledge was not general, nor anywhere accessible to others!

The literature of engineering is substantially bare of instruction concerning column design, except in so far as to quote and discuss so-called column-formulas. Theoretical study of column riveting, latticing, end-connections, types of cross-section, etc.; and practical discussion of the influence of various constructive modifications, inaccuracies, and the like, are absent from the writings to which engineers look for guidance. Let them search their treatises or textbooks or the discussions before their technical societies: they will find nothing to warrant them, for example, in condemning the compression chords which buckled in the fall of the Quebec Bridge, or asserting that this or that design for similar members were better.

Knowledge of column design has advanced in the few weeks just past—advanced rapidly. Many engineers now are willing to say unqualifiedly that such and such chords and posts are weak or inadequate. A great light has come to many of us, and by it we see that the knowledge we have had is not as complete as it should be. This is a very recent realization, however. Moreover, it must not be confused with the actual acquisition of the knowledge which we now know we did not possess.

Carefully considered, all that we know now is that our previous knowledge has not been adequate. Let us not fall into the mistake of thinking that our recognition of this previous ignorance has brought with it the supply of all the knowledge needed to make up the deficiency. By the light of the Quebec collapse we see, for example, that such or such a design is weak; and we can go farther and suggest various improvements. But have we any criterion as to the merit of these suggestions? No; quite the contrary. We are little farther advanced than we were when the Quebec Bridge members were designed. Neither complete theory nor fuller test data is at hand to guide us in building safe columns. It is still the work of the future to produce this material.

A year ago we suggested in these columns the feasibility of shipping cement for use on large works in bulk, in order to avoid the expense of packages and to secure more certain results in mixing concrete than can be had where the accuracy of the count of bags into a batch is the sole reliance.

The matter of the cement to be used on the great locks and other structures for the Panama Canal has been the subject of much study and investigation by the Canal Commission; and we understand that an entirely novel plan of procuring cement for that work is likely to be adopted. As our readers know, for shipment by sea the common requirement is that cement shall be packed in wooden barrels; and at the present prices of cooperage stock, this means an enormous addition to the cost of the cement. On the other hand, the exposure of ground cement either in bags or in bulk to sea air would involve risk of injury. The present proposal, therefore, is to purchase the burned cement clinker, ship it to the Isthmus in bulk and grind it there in mills set up close to the work where the cement is to be used, so that the ground cement will not have to be packed at all. The "Canal Record" of Oct. 2 states that bids for furnishing cement, both ground and in clinker form, are likely soon to be called for.

In our last week's issue we published in this column comments on the destruction by fire of the Fourteenth Street car house of the Interurban Street Ry. Co., in New York City, with sketches showing the fireproofing of the floor girders. The gist of our criticism was that the building as erected had the lower part of the floor girders unprotected by fireproofing so that the girders deflected and the floors came down under the attack of flames.

We also stated, however, that the plans and specifications as made by the architect called for partial protection of the lower flanges of these girders, but that the builder erected the structure without the beam protecting skewbacks, notwithstanding an offer by the fireproofing manufacturers to furnish them. We now find on further inquiry that through a misunderstanding, this part of the information furnished us was erroneous. From a blue-print furnished us by the architect it appears that the floor girder fireproofing as actually erected (corresponding substantially to Plan C, on page 413 of our last issue) was in conformity with the architect's plans; and the builders inform us that they have no record of any proposi-

tion being made to them to change the floor arch construction in any way whatsoever. Under these circumstances no blame can attach to the builders for the type of construction erected and our apologies are tendered to them for the error.

## ENGINEERING AND THE COMMERCIAL VIEW.

There is to-day no lack of enthusiasm for the business aspect of engineering, or, rather, for that view of the engineer which makes him primarily a business man. This is an inevitable view, and an obtrusive one. Inevitable, because the engineer, like most other men, lives by the income of his daily work and consequently is successful in the popular eye according to the dimensions of his income. Obtrusive, because in recent years many factors co-operating have made the financial, commercial and administrative relationships of engineering work grow very much faster than its purely technical side. The remarkable increase in the number of students at engineering colleges, beginning some six or eight years ago, was evidently a symptom of this growth, for the demand from purely technical circles for engineering graduates had no similar increase. Correspondingly there has come a call for fuller development of the business faculties in engineers, and very naturally this call was heard and appreciated chiefly by the younger contingent of the profession, including the students still in college. Enthusiasm being an inverse function of age, it happened that business ability came to be made in a small way a sort of fetish in these circles.

Teachers of engineering in many cases have contributed actively to the enthusiastic appreciation of business skill. More than one professor has taken special pains to impress his students with the sentiment, or at least has succeeded in impressing them with the sentiment, that business skill, being of far greater effect in securing materialistic success—making money or securing place and power—is for that reason more desirable, more to be striven for, than mere engineering ability. Inferentially, these men tended to create a belief that the engineering faculties and acquirements proper are wholly secondary, useful only in so far as they increase the effectiveness of the business faculties. Such a view is extreme, distorted, and in its relation to the engineering profession degrading. It constitutes a professional stultification which can arise only from lamentable lack of mental balance.

But in its due proportion the commercial view is quite proper and necessary. Quite aside from the fact that the engineer's work is *caused* by commercial or financial dealings, is frequently limited by them, and creates as well as employs them, we have only to consider that engineering service itself is a business like any other, exhibiting the same phenomena as any other form of commerce, and subject to the same laws.

It does not appear to us that any erroneous or dangerous tendencies should derive from these facts, or wrong principles be deduced from their recognition. There is no obvious reason why the business view should lead to any conclusions, as to proper and improper procedure, inconsistent with the conclusions dictated by a strictly professional view. But there are indications that divergent conclusions *are* often arrived at. Not infrequently we hear this or that action of one man or a set of men—engineers undoubtedly, by training and practice—called commercial, in the sense of venial, and attributed to a "commercial spirit"; in other terms, something other than the professional spirit. And, on the other hand, there is sometimes to be found, among old engineers chiefly, an over-rigidity of bearing in matters that lie on the border line of professional work (or aside from its main fields), which, though it may be intended as a silent protest against less pure views of professional conduct nowadays current, is classed by their more up-to-date younger brethren as old-fogyism.

It is a fact that there are occasional departures from long-accepted standards, in present-day engineering practice. No very intimate acquaintance with the field of technical enterprise is needed to find them. Thus, it used to be made a rigid rule of professional conduct that, just as a physician must not seek to advertise himself, so the engineer must observe a similar degree of formal professional dignity; bearing in mind, of course, that as he does not deal with a clientage that passes his door his methods are necessarily different, and he may substitute a printed, currently-published, "shingle" for the painted one. But clear as this rule and its limitations seem to be, to-day we see not rarely that engineers or engineering firms or corporations court publicity by the methods of the advertising expert, the remote successor of the county-fair barker and the patent-medicine charlatan. Again, by an allied rule we were told that it was not proper to seek, or endeavor by politician-like and office-seeking methods to secure consulting engagements. Yet this thing is sometimes done to-day, and that not by beginners, comparable perhaps to the ambulance-chasing young lawyer, but by widely-known men of high-standing. Or, to cite a third point, we can refer to the old principle that an engineer should not have financial interest in any part of the work he designs. This principle is broken square in two, every day, by a number of "consulting and designing" engineers, who, maintaining a complete but not always widely-advertised affiliation with particular manufacturing or contracting interests, always ensure the participation of these interests in work for which they are personally retained.

If actions of the kind typified by these examples—more could be cited—claim justification by the business view, and if the business view is a safe and proper one, then either one of two things must be true: That former views of professional propriety are now no longer satisfactory, as they impose unnecessary fettering restrictions; or that, if the old standards are still valid, the logic is erroneous by which actions of the kind mentioned are deduced from the business view of engineering.

Our own reflections lead us to accept the latter conclusion. It seems to us, on the one hand, that a sound, consistent, business-like view of any occupation, therefore also engineering, can not but yield a reliable basis for action; and on the other hand, that the old professional standards, founded on good principle and good work, are as applicable to-day as they ever were—with minor modifications perhaps, but in substance still the same old standards. We feel that the logic by which the more serious infractions of the ethics of professional conduct are sought to be justified is an essentially faulty one.

It is worth while, therefore, to inquire whether the business view, made a starting-point in an examination of engineering propriety, may not be made to yield results which can be recognized as true ones. This need not be a philosophical inquiry, nor a lengthy one, but in fact can be quite practical and brief. Let the following serve as an attempt to outline such an inquiry.

To begin with, we have it that engineering service is a business. As in all other business established on a basis of soundness and permanency, its *successful* performance demands primarily *excellent* performance, firstly for the sake of the performance itself, and secondly for establishing a proper repute, the confidence of all actual and potential parties of the second part. This confidence, basing on both the character of performance and the man, may be typified in the abstract thus: "I believe what you say." But in its application to ordinary business and to engineering service it takes distinct forms. The merchant or manufacturer aims at confidence of this form: "I will buy your wares, or your products." He seeks to establish faith in certain concrete things, and in himself only as related to these things and as occupying the same relation to this known article and that other unknown article. The engineer strives to merit confidence in another form, as thus: "I will do what you recommend." There is no concrete object of faith here; the faith is in the man. Engineering is a business of the individual, and necessarily has individualistic character.

This difference at once leads to further differences. Thus, it is quite proper for the business man to say, "Buy my wares; they are good." No obtrusively personal character enters with this statement. But the engineer can not properly say, "Seek my advice; I am good," or "My service is good." Human nature does not permit it. Self-praise is not looked upon as true praise. The reflexive judgment is not considered reliable in its working, and the practice of asserting it receives no countenance.

Besides this difference in the general aspect of the business, there is a difference in the kinds of service involved in ordinary commercial and in engineering business. In the case of the merchant or manufacturer, the test of inspection, trial, etc., is available to the purchaser. The wares speak for themselves. Engineering service, quite differently, is a service of judgment, and not of something tangible. The judgment is inherent in the *man*. It cannot be laid out on the counter, for handling, critical inspection, or actual test. It is not susceptible of proof or check until long after it has been accepted. The nature of the judgment in question is more or less elusive to attempts at definition. It includes as ingredients the effects of trained observation, learning and practical skill, but in addition also a large spice of a more individual quality of much complexity, a compound of strength of mind, quick discernment, analytical perception of purpose and means, sharply practical or objective view, etc. Yet, as it is imperatively necessary to the engineer, and confidence in it on the part of the client is a condition precedent to the transaction of business, every means must be employed by the engineer to safeguard its accuracy and efficiency and as well to safeguard its reputation. As it is a function whose vital energy is derived from recognition and promotion of truth, and whose reputation similarly depends on the assertion of truth, free from baser admixture, as of self-interest or partisan bias, we see that these things are dictated to the engineer as being essential to the successful prosecution of his business.

A variety of other comparisons and differentiations between engineering and other business strike the observer. Engineering service knows no cost-price, selling-price and margin of profit, whose relative adjustment determines success in ordinary commerce. The securing of profit by reduction of cost-price, increase in quantity of business, etc., which gives rise to and justifies the dickering, the chase for the purchaser, the hypnotic stimulation of buying, etc., in the business of trade, does not enter the engineer's calculations. The trader who can create a slightly increased desire on the part of the purchaser, enough to bring about a transaction at somewhat higher price than otherwise could be obtained, or to increase the volume of business without change of price, multiplies his profit. These actions, therefore, as they transgress no principles of fairness, are right actions, in fact commendable ones, for the trader. In engineering business they have no field for action, and therefore they are wrong. The proprieties of every occupation or manner of activity are fixed by the necessities of that occupation.

The nature of the engineer's clientage corresponds to the nature of his services. As the latter, so is the former personal; and of necessity so, since the personal relation is inseparable from the business. The man of commerce displays his wares to the world and invites the world to see, try and purchase. Except for minor difficulties of management, he might entirely eliminate the human being from his organization, and carry on his business by slot-machines. What, in fact, is the mail-order business but a form of automatic trading? Such methods, natural enough in mere buying and selling, are unthinkable in engineering work. The department-store, the mail-order house, the slot-machine, have no place in that field. Instead, there is always as a characteristic the relation of man to man direct, necessitating the establishment of a personal, human intercourse.

The merchant's client may be satisfied to see the sign: "Dry Goods," and he may thereupon go and buy. The engineer's client is not satis-

fied to see the sign "Engineer"; the human element must be palpable, there must be a name, the representation and assertion of a personality. Is it conceivable that there could be maintained a "Bee-Hive Consulting Engineering Co.," with manager, assignment clerk, and correspondents, where hydraulic inquiries would be referred to Department A, electric lighting matters to Department Q, etc., and rubber-stamp "opinions" returned? The company might indeed find clients; it might even prosper. But its business would not be an engineering one half so much as a gambling enterprise.

Equally important is another comparison. The product which the engineer sells knows no "seconds," no Clear, Prime and Medium grades. It has but one quality, in spite of its ever-varying details. The engineer cannot put the inferior specimens of this output on the bargain-counter, equalizing in price the deficiency in quality. It follows that a rare consistency and uniformity of mental temper must mark his work. This is not to be attained, as perhaps in the exercise of the fine arts, by an idealizing abstraction of personality from the gross world. For, the engineer must keep in the most intimate contact with this world and all its phenomena. And while in his own output he must know but one grade, he must be able at all times to appreciate keenly and soberly the variations of quality exterior to himself.

This necessity devolving upon the engineer of placing his own work on a level off from the level of other things, while yet maintaining himself in immediate contact with the world, gives rise to a peculiar condition. To maintain the difference of level, a sort of moral force must be brought into play, expressing itself in an appreciation of engineering work as above the moral standing of other business. Something very like the judicial spirit in law must pervade the engineer, if he be worthy. That he must possess such complete abstraction from the advocate's viewpoint and even from being sensible to influence by the advocate's art, and such independent denial of all collateral interest, as mark the judicial poise, is a secondary, though a very important, conclusion. It is also a postulate that he may not combine the vendor or contractor with the judicially minded engineer in one person—an important conclusion, but still secondary. The primary fact is that the engineer must have as his guiding star a peculiar moral appreciation of his work and its rank, in order to maintain himself successfully and permanently in that dual position of knowing but one excellence for his own product and infinite gradations of excellence for everything else. The lamp of truth, sugested by an earlier comparison, is again urged as a vital spirit.

From such considerations, developed into a fuller logical structure, may be derived, we believe, rules of practice not vitally different from those long followed as rules based on the professional view. Those forms of conduct which strike one as violations of professional propriety, are condemned by the standard of business as strongly as by the more ethereal standard of professional ethics. The engineer who takes from one set of interests a permanent retainer as expert witness in patent causes can find no more justification in argument from a business premise than in the older categorical rules of professional conduct. It is not advice or judgment that he sells, but a reputation; and that never was good business. The engineer who, in the guise of a professional discussion, argues with open or half-concealed partiality for the side of his employers (not only in a single case, where he might properly be assumed to express his own best conclusions, but in every case that offers) cannot be said to act in the business interests of either himself or his employers. His expressions of opinion, private or public, can no longer have currency as engineering judgment, for has he not shown that they may be adapted with acrobatic flexibility to immediate materialistic gain! And his employer loses the advantage he might have gained from recognized and reliable engineering approval, though of more moderate character, having bargained this for the more clamorous assertions of partisanship. The much-published name of the speaker, the "Dr. This" and "Dr. That," which seek to give a false impress of impartiality and reliability to such assertions, do not help the matter, meanwhile injuring their own virtue.

The business view, we believe, is a good view. The commercial basis for professional conduct is not the degrading thing it is sometimes thought to be. Nor is it an *unsafe* basis. It can only be deceptive or misleading, it appears to us, through the effect of such perversion of logic as will suffice to render unsafe the most exalted foundation for a system of ethics. The current enthusiasm for business standards in engineering, of which we spoke at the outset, is a useful spirit, inasmuch as it represents the recognition of a little-considered factor from which no erroneous results are to be apprehended.

And therefore, with proper interpretation of the teachings so derivable, there is no need for a code of engineering ethics. It may be, in some branches of engineering industry, that undesirable practices have found currency and grown to proportions so large that the dogmatic guidance of an express set of rules is needed to limit them. A recent attempt at such a code, indeed, suggests this. There are many men who will not recognize the dictates of a more remote advantage, and the hurried profiting by temporary gain may become a fashion. Under such conditions the soundness of the teachings of the business view is vitiated; and of course the more abstract moral view per se is incapable of helping out, for it must have gone by the board at an earlier stage.

The *so-called* "commercial" spirit which is invoked to justify radical departure from clear rules of engineering propriety should receive its proper condemnation. Let it be forgotten as a false guide. Let those who sought its aid endeavor to return to the conservative spirit; if needful, let them translate themselves back to the olden days, when a consulting engineer was *always* an independent center of thought and when men were not accustomed to having their engineering service "done" by a contractor, actual or prospective.

## LETTERS TO THE EDITOR.

### Practical Experience Wanted in the Use of Lime Mortar in Place of Cement.

Sir: I would be glad if you would open your columns to a discussion of the relative merits of lime and cement in localities where the cost of the latter is excessive. It is true that there is little to be said in favor of lime when cement can be procured at a reasonable price, but in Mexico and in many parts of the United States the cost of cement is so great as to make its use in many engineering structures almost prohibitive.

Take for instance a dam to be constructed at some inland point where cement would cost $8.00 per barrel (all prices are given in U. S. currency, for convenience) delivered on the work, large rubble stone and sand are available on the dam site and lime costs $3.50 per long ton delivered on the work. Under these conditions, with a dam 100 feet high with a 75-ft. base, would it be considered good practice to build the core of the dam of rubble masonry with lime mortar, building the front and back faces with cement mortar? With such construction how thick should the portions laid in cement be? In building such a dam in one season of six months, would the lime mortar set sufficiently to be safe? In order to facilitate the setting of the lime mortar would it be advisable to leave chimneys extending to the top of the dam?

Yours truly,

A. M. Shaw.

Zacatecas, Zac., Mexico, Oct. 7, 1907.

[We will be glad to give space to opinions and experience on these questions.—Ed.]

### The Strength of Hooped Concrete Columns.

Sir: The article in your issue of Sept. 26, entitled "Strength Tests of Hooped Concrete Columns," sheds valuable light on the question of what safe load can be imposed on such columns. The ratio of the moduli of elasticity of steel and concrete in the columns tested is apparently not a constant, but a variable quantity. An average of 12, however, seems to check fairly well. If vertical reinforcement was introduced, this ratio of 12 would give 6,000 lbs. unit-stress in the steel, when the concrete carries 500 lbs. per sq. in., and when the concrete sustains a load of 1,600 lbs. per sq. in. the steel would have 19,200 lbs. unit-stress, an amount considerably less than the elastic limit of medium steel. Assuming that, because of excessive deformation in shortening, 2,100 lbs. per sq. in. is the limit of strength which can be considered, the corresponding unit-stress in the vertical steel at a ratio of 12 would be 25,200 lbs., an amount still well within the elastic limit. From this it seems apparent that the vertical steel is always stressed safely below its elastic limit, since the concrete is seldom stressed beyond (if indeed it ever reaches) 1,600 lbs. per sq. in. Using a factor of safety of 2 with the above maximum stresses, the allowable working stress, on the concrete and the steel respectively, would be 1,050 and 12,600 lbs. per sq. in. At these stresses, as the tests show, the hoops or spirals are working comparatively little, which seems to indicate the fallacy in heavy hooping. Hence, apparently, where heavy loads are to be carried on small columns, it will be expedient to introduce sufficient vertical steel to reduce the pressure on the concrete to the desired allowable stress.

From the similarity of behavior of these concrete columns to those of other materials, under load, it would seem that a slenderness-ratio-factor should be introduced in the design formula, particularly in computing long columns of small diameter.

Yours very truly,

Hector R. Burroughs,
Structural Engineer, Southern Pacific Co.

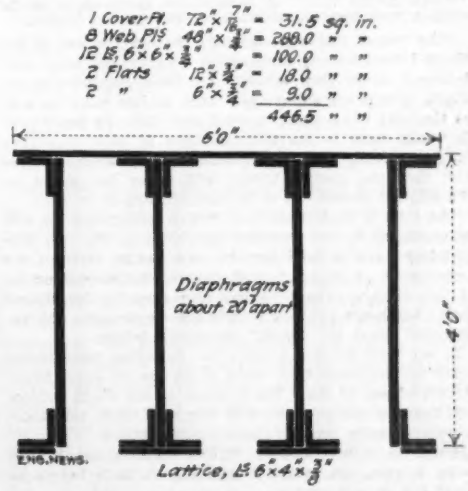
San Francisco, Cal., Oct. 3, 1907.

### Two Questions of Column Design; The Design of Compression Members for Large Bridges, and Butt Joints in Columns of Buildings.

Sir: While I appreciate the thorough way in which you have written up the Quebec disaster, I have, like Mr. Bainbridge, felt inclined to take some exceptions to your conclusion that engineers don't know how to design heavy columns and beg to send you a cross-section of a compression member I designed for a proposed 1,250-ft. span cantilever at Montreal over twelve years ago. At that time you published one of my designs among others, so the plan I now send you was in your office for some time in 1895.

The cross-section [shown herewith—Ed.] was for 446.5 sq. ins. and was designed before the day of 8 × 8-in. angles in Canada, otherwise the larger angles would have been used.

The lattice angles and diaphragms were referred to but not shown on the drawing. This cross-section represents, I think, the usual practice at that date. Every




Cross-Section of Largest Compression-Member of Design "C" for 1,250-Ft. Cantilever Bridge at Montreal, Designed in May, 1895; T. Kennard Thomson.

year engineers see the wisdom of building stronger bridges, on account of wear and tear and constantly increasing loads.

I am glad to see that you refer to the danger of butt joints in discussing the Quebec bridge, as it is a subject that should be kept constantly in the minds of those who design and erect New York skyscrapers—for we all know how extremely difficult it is to get absolutely true and square joints, and that the very slightest error in the joint will throw the column a good many inches out of plumb. Naturally people like to have their buildings plumb, and besides, in New York City, being out of plumb means encroaching on another man's property and usually a law suit and heavy damages. The result is, as we all know, that most erectors use more or less dras-

tic methods of plumbing up after a number of stories have been erected, which with purely butt joints would be sure to open up the joint, throwing all the strain on one side of the column, which even the layman should know is dangerous, to say the least.

At present there is not much use specifying that joints shall be fully spliced any more than to have insisted that a chord like No. 9 of the Quebec bridge, *as it was designed*, should have enough rivets to transmit the entire strain. Nor could the matter be remedied by putting jacks or wedges under the columns, because there are so many joints in a high building that they are not likely to be all out in the same direction, so all that we can do at present is to put in as many rivets in the joint as conditions will allow and to keep on warning and watching the erectors.

Most high buildings have a thin layer of some comparatively soft material like sheet lead under the steel or cast-iron shoe which takes up slight inaccuracies at the start, but it would be too dangerous to try any similar expedient in a butt joint.

Very truly,

T. Kennard Thomson.

Park Row Bldg., New York City, Oct. 19 1907.

## The Quebec Bridge: A Counterpart of the Forth Bridge Suggested.

Sir: I have closely followed your editorials and articles and also the letters which are being contributed to your columns on the Quebec bridge failure. These letters indicate varying opinions, but one fact is cold and clear and it is that this failure lies at the doors of the United States bridge designers (the builders and erectors have been proved blameless). This being the fact, what is the next best thing to do? Avoid these failures in the future. How?

The United States has a great National engineering society, one of the best in the world: the American Society of Civil Engineers. As was well suggested two or three weeks ago by another journal, let that society appoint a strong expert commission from its membership to inquire into the design of this bridge. As this would be a work having for its object the safe transportation of the American people, it would seem to be not altogether improbable that a Federal Government grant to defray part if not all of the costs of such an inquiry might be obtained from Washington.

In your issue of Oct. 3 you publish an article entitled "Compression Members of the Quebec Bridge." In commenting on circular form versus flat plates you say in part:

> The disadvantage of curved plates, in making connections and in fact at every point in the whole process of production of a structure, from the original outline on the drawing board to the final completed fabric, is so serious that no one can seriously propose the use of the "Forth Bridge type" of compression members, even for such a monumental structure as the Quebec bridge.

Why cannot any one seriously propose the use of the Forth bridge type of compression members for large span bridges? Have they failed? Are these members in the Forth bridge not doing their work to-day quite as well as they did when traffic started over them 19 years ago? It would seem to me that the time is most opportune for just exactly such a proposition and I venture to predict that the Quebec bridge will never be rebuilt on the original design, let it be strengthened as it may.

The time is past when any further experimenting will be permitted by the Canadian Government, who will now certainly have to take into its own hands, through the Department of Railways and Canals, the reconstruction of this bridge. The time has also gone by for United States engineers (who as a body are clever, able and resourceful men) to "knock" the Forth bridge.

In my very humble opinion the Canadian Government could not do better than build at Quebec an exact counterpart of one of the 1,710-ft. spans of the Forth bridge, adopting the design essentially but with such variations as future traffic considerations would suggest.

It may be clumsy looking; it may have too much steel in it; it may cost more; it may take a little longer to erect; but it will stay up.

Thanking you, I am

Very truly yours,

An Old Canadian Subscriber.

Oct. 15, 1907.

[It is by no means "cold and clear" as yet that sole responsibility for the Quebec disaster is to be laid at the door of "the United States bridge designers." It is still to be determined under what conditions these bridge designers and bridge engineers were working.

As for the suggestion that the American Society of Civil Engineers appoint a commission to inquire into the Quebec disaster, it seems to us that any such action should at least be delayed until the Canadian engineering commission completes its investigation and presents its report.

Any commission appointed by an engineering society would necessarily have extremely limited powers compared with those under which the Government commission is working, and could not be expected to devote anything like the time to the work that Messrs. Holgate, Kerry and Galbraith, the members of the Canadian Commission, are giving. If there are other questions on which some further statement by professional authorities is deemed desirable, action can be taken after the results of the Canadian official investigations are made public.

As to building great bridges piece by piece in the field, as the Forth bridge was built, we believe that structural engineers the world over are now convinced that the American system of building the truss members in the shop and erecting them, member by member in the field, is far more economical, and produces a better and safer structure. We now know enough of the causes of the Quebec disaster to say positively that confidence in the American system of bridge construction need not be in the least shaken.—Ed.]

## Fog Signaling on English Railways.

Sir: In your issue of Aug. 8 I see some notes on English railway track which are, in the main, very accurate. The author, however, is not fully informed on the endeavors we are making in England to solve the fog signaling problem. While he is perfectly accurate in describing the use of fogmen and torpedoes (or fog signals as we call them) as the method in general use, one or two of our railways, notably the Northeastern Ry., are endeavoring to develop devices which give a visible (and sometimes audible) signal in the cab. The Raven system has been employed for several years on the Northeastern Ry. and is being gradually extended, as the defects are discovered and overcome.

We have, it is true, very few devices for placing torpedoes on the rails. Many have been tried, but none has so far proved itself entirely trustworthy. But even if such a system can be brought to perfection, I think you will agree with me that it is not to be compared with cab signals. The latter would always be in action, clear or foggy, and any defects would be quickly discovered while the former, being used but intermittently, would be far more likely to get out of order and the defects less likely to be discovered quickly.

The difficulties of cab signaling are, step by step, being overcome by the many workers engaged upon its problems, and it will no doubt some day be extensively employed.

Yours faithfully. Railway.

London, England, Sept. 14, 1907.

[The writer of the article referred to was not unfamiliar with the experiments made with fog-signal apparatus on English railways, but the use of apparatus of this kind is so limited (as our correspondent shows) as to call for little more than brief mention in general notes on English track and track work. The troubles due to fog are among the serious difficulties in railway operation in England, and it seems strange that in 10 or 20 years of modern development so little real progress has been made towards perfecting or adopting auxiliary signal apparatus to eliminate the dangerous conditions. The Dixon torpedo-operating fog-signal apparatus, which was tried on several English railways, was described in our issue of March 29, 1894, and in our issue of May 2, 1907, we described the cab signal apparatus recently tried on the Great Western Ry. (England). It is to be noted that this is an invention of the company's signal engineer.

It is true that cab signals have certain advantages, but they have the objection of requiring every engine on the division to be equipped with the electrical apparatus, while a torpedo signal on the track will be operated by anything that passes over it. Automatic stops operated in connection with the track signals (and automatically applying the brakes) have been successfully and extensively used on electric railways, but only to a limited extent on steam railways. A failure of such a device on a London electric railway was noted in our issue of July 12, 1906. There appears to us to be little prospect of anything but experimental use of either cab signals or automatic systems in general railway service for very many years. The torpedo signal, however, is a much simpler proposition, and might well be given serious attention by railways having trouble due to fog.—Ed.]

## Can Concrete Be Made Watertight?

Sir: Referring to your editorial of Sept. 26, entitled "A Simple Way of Making Waterproof Concrete," in which you review the paper, in your issue of September 5, entitled "The Permeability of Concrete and Methods of Waterproofing," presented by Mr. R. H. Gaines, of the Board of Water Supply, New York City, I beg to make the following comments:

(1) Assuming that concrete per se may be made impermeable, if this impermeability will not prevent cracking, and as cracking will destroy the value of impermeability, why attempt to make concrete impermeable?

Granted that limited impermeability, as it were, is a desirable quality, is there not needed, however, something additional for dependable and perfect waterproofness for general conditions and practical work?

(2) There is a fine distinction between testing concrete for strength, and testing it for watertightness. If it requires special care and watchfulness for the making and testing of cement at the mill to the proper testing and mixing of it in the field to obtain adamantine concrete, how much more difficult will it be to get great bodies or masses of concrete so perfectly constituted as to be perfectly watertight? There will, in either case, always continue to exist zones weak in quality and density.

(3) Waterproofness is not what it is to-day, but years hence. Because a briquette, or cube, or box of specially treated concrete remains watertight in or out of a laboratory for one or twelve months is no warranty that concrete can be made permanently watertight for practical purposes. Assuming even that there can be had concrete in monolithic form so perfect in texture and mixture as the specially prepared laboratory sample, masses of concrete in the open are subject to conditions, especially in this latitude, impossible of ascertainment and test in a laboratory sample, to extremes of heat and cold, to settlement, to contraction and expansion, to earth tremors, both natural and artificial, resulting in fractures, the opening of pores, etc., a process which certainly does not decrease with the advance of years. Water will come through concrete in time. It will take longer to work through so-called "watertight concrete," but it will eventually come through it. Otherwise it would be contrary to the law of physics and nature. The same principle applies, of course, to cement plasters and hardening compounds for the surface. As your editorial correctly states, such "exterior coating waterproofings . . . are of too fragile a nature to be the sole defense of the structure against percolation." And Mr. Gaines also states as to his analyses and strength tests, "The results showed that some of the so-called 'waterproofing compounds' were worse than useless."

To provide against settlement, contraction, expansion and cracks, something independent of, and apart from, the concrete should be provided to protect and waterproof it, instead of depending solely upon the concrete itself.

(4) The real theory of waterproofing is insulation. Insulation and waterproofing are correlative. There can be no natural waterproofing without insulation. It is a natural law. Therefore any other method would seem to be erroneous. How can it be otherwise? This is the basis of what the writer some time since termed "the membrane method," which means the interposition between the concrete and moisture, and between the concrete and the earth, of a flexible, permanent, watertight membrane which prevents moisture from coming in contact with the concrete—waterproofing, and also insulating it against both water and electrolysis. So-called watertight concrete is not in itself proof against electrolysis.

The placing of the above described stratum or membrane depends upon conditions and the use to which the structure is to be put.

(5) If this theory is right, the matter of materials will solve itself. The first question is to decide upon method, and, having done so, next turn to the scientific perfection of the appropriate materials.

(6) The writer sincerely believes that to attempt to waterproof the new aqueduct for the City of Greater New York, by making the concrete itself impermeable, will in time end disastrously. The water is not to be brought for power, but for drinking purposes, and should be delivered as pure as possible. This cannot be done if along its route it takes in impurities and surface waters through cracks which must eventually develop, to a greater or less degree, in the concrete forming the aqueduct. The conditions would grow in seriousness.

No work of the Board of Water Supply is more important than to arrive at a correct method of making the aqueduct perfectly and permanently watertight, which it will be impossible to do by depending solely upon making the concrete in itself watertight.

Very truly yours,

Edw. W. De Knight, Manager,

Hydrex Felt & Engineering Co.

120 Liberty St., New York, Oct. 8, 1907.

[The science of waterproofing has not reached the point where it can be called perfect. Insulating coverings are liable to accident to nearly as large a degree as the insulated concrete. It would therefore seem that the double protection of a covering and a more impervious concrete, is not too great for the state of the art. Even if the simple methods proposed by Mr. Gaines do not give infallibly water-tight structures in practice, if they add materially to the impermeability of those structures, they will serve a useful purpose.

The last argument of the writer, i. e., that impure water percolating through cracks will cause pollution, does not take into account the fact that the water is to be delivered to the city under a very great head and that the pressure in the conduits will scarcely allow any surface or ground waters to enter. The result of any cracks would be leakage, which of course is undesirable, but there could be no pollution of the water supply.—Ed.]

## Notes and Queries.

In the article on "Uniform Symbols For Wiring Plans" on page 406 of the issue of October 17, the fraction 4/8, printed with the symbols for gas and combination fixtures, should not have appeared with the symbols for gas fixtures. It is perfectly evident from the article that the "4" of the fraction can refer only to 16-CP. incandescent electric lights; hence the mistake can hardly have deceived anyone.

Information on the bending strength of corrugated steel sheets is desired by Mr. F. L. Burr, of Vulcan, Mich., who says that he has written to several manufacturers for such data, without results, but believes that other makers of corrugated steel have data of the kind. The immediate problem in hand is to determine the required gage or thickness of steel which, corrugated ¾-in. deep by 3 ins. wide, will carry a given load on a given span.

We know of no experiments made on the subject.

A formula is given in the Carnegie "Pocket Companion," as follows:

$$W = \frac{99{,}900\ t\ b\ d}{l}$$

where $W$ = breaking load, in pounds.
$t$ = thickness of metal, in inches.
$b$ = width center to center of corrugations, in inches.
$d$ = depth of corrugation, in inches.
$l$ = length of span, in inches.

A similar formula is given in the Pencoyd handbook, "Steel in Construction." These formulas seem wrong as they make the breaking load per square foot increase with the width of corrugation, that is, a sheet is given a greater strength by making the corrugations flatter in shape, for a given depth.

Referring to his letter on "Compression Carried by Lattice Members of Columns," in our issue of Oct. 3, Mr. John Bartholomew calls attention to his error in using the net area of section of the cross-tie for calculating the relative stresses in tie and diagonal. The gross area should have been used. Applying this to the example there given, the ratio of areas becomes 0.925, in place of 4/8, and the ratio of unit-stresses becomes ¼ ÷ 0.925 = 1.52, in place of 1.75. From this the unit-stress in the diagonal is found to be 28.5% of the unit-stress in the main member, instead of 27.6%, as given. The use of net area in place of gross area was also remarked on by Mr. A. B. Hager in our issue of Oct. 10. Mr. Bartholomew's correction, written on Oct. 8, was received too late for insertion in that issue.

WIRELESS TELEPHONE EQUIPMENT will be installed on the ships of Admiral Evans' fleet before they leave on the Pacific cruise. Experimental trials have proven the system used to be successful for distances up to six miles. The system employs the De Forest transmitter, and the messages may be received with the ordinary wireless telegraph receiver.

In practice the operator uses the ordinary head receiver, which picks up the tick signals of the telegraph and also the voice of the telephone operator. Lieut.-Commander Cleland Davis, the Navy's authority on wireless transmission, states that while it is true that the telegraph aerial may be used for the transmission of telephone signals, it is desirable to have a separate aerial for telephone use and that it is probable that this will be provided on the ships of the fleet.

In this connection it may be interesting to note that the ships are also to be equipped with telephonic fire-control apparatus. This equipment will involve the construction, beneath the protected deck, of several separate telephone booth exchanges. These booths will connect both by telephone and by speaking-tubes with the captain's station on the bridge, and with the conning tower. There will be one booth for guns of each caliber.

## THE SURVEY OF THE MADEIRA AND MAMORE R. R. IN BRAZIL.

By ERNEST H. LIEBEL.*

In the advertising columns of Engineering News during the past few months there has appeared what would, at the first glance, appear to be an exceptionally attractive offer for young railroad engineers with tropical experience. It can safely be assumed that these announcements as well as the circulars, setting forth in detail the terms of employment and alleged extensive preparations for the proper conduct of the work, which are being mailed to applicants for the apparently lucrative positions offered, have aroused a general interest in the scope and purpose of the project in question. It is, therefore, the object of this report to chronicle the experiences of the first expedition of engineers which left New York on May 6 of this year.

It may be well to preface this record with a general description of the territory through which the proposed line will pass, together with an outline plan of the work. The project, known generally as the Madeira-Mamore Railway, lies wholly within the Estado do Matto Grosso (State of the Great Forests) and has for its termini the small border settlements or villages of Santo Antonio, located at a point on the south bank of the Rio Madeira approximately 65° 50′ W. and 8° 40′ S. of the equator, and Guajara Marim at approximately 67° 40′ W. and 10° 40′ S. on the east bank of the Rio Mamore. From these two important tributaries of the Amazon the project derives its name; and the navigable stretches of these rivers, lying above and below the falls at the two named points, it is proposed to connect by this railway.

THE ENGINEERING PARTY FOR THE MADEIRA & MAMORE R. R. SURVEY.

Taken on Board the Steamer en Route for Brazil, when Crossing the Equator.

Left to Right, Standing, (1) O. Lindboe; (2) H. C. Miller, Chief; (3) R. A. Barton; (4) F. Winlack; (5) W. L. Sisson, Principal Assistant; (6) J. K. Flick; (7) E. E. Shivers, M. D.; (8) C. Isaacs; (9) R. C. Mount.

Front Row, Left to Right, Sitting, (1) E. Royer; (2) E. H. Liebel, Chief of Party; (3) W. H. Crago, Chief of Party; (4) R. L. Burney.

The obligation to construct this much needed means of communication, between the upper fabulously rich and undeveloped rubber and gold districts of the Amazon and the great water highway of commerce, the Amazon, has been saddled on the Federal Government of Brazil by the terms of a treaty with the Bolivian Government, which in turn ceded to Brazil the title to what is perhaps the richest of the mineral and rubber districts of the Andean foothills—the Acre territory.

As far back as the early '70's an attempt at the construction of this railway was made, and the failure of the first effort, almost at its very inception, is recorded in the pathetic history of the ill-fated Collins expedition.†

The concessions under which future operations are to be conducted, have since passed to a Dr. Catramby, of Rio de Janeiro, who succeeded in securing the aid of a distinguished American promoter, Mr. Percival Farquhar, with whom he has entered into an agreement for the exploitation of the concession, a subsidy of $10,000,000 gold having been appropriated by the Brazilian Government, to insure the proper prosecution of the work. Coincident with the organization by a corporation to undertake the financing of the scheme, immediately initiated by the Farquhar interests, power of directorate over the organization of the engineering staff to conduct the preliminary explorations of that territory was vested in the construction firm of May & Jeckyll, a subsidiary corporation of the allied interests; and the field work to date has been under their direction. Mr. R. H. May, senior member of the contracting company, and holding power of attorney for the promoters, has been in charge of the scheme since the beginning of operations; he is in effect the Chief Engineer of the corporation, being assisted by Mr. Harvey C. Miller, M. Am. Soc. C. E., who is known as the Assistant Chief Engineer of the railway. Mr. May is well known by virtue of his construction of the Cuban railways and his long and intimate association with Sir William Van Horne, of Canadian Pacific fame.

The probable length of the line varies between 250 and 325 miles, depending upon the route assumed to be the most available for construction; as it will be noted that the Madeira River forms a more or less clearly defined arc, subtended by a chord between the proposed termini, the middle ordinate being about 45 miles in length. The proper location of the road, therefore, involves a careful study of the range of territory thus afforded, in conjunction with the customary comparisons of first cost and ultimate economy of the various acceptable routes which it may be possible to locate after the exploration notes and data have been systematically chartered.

By far the most important feature to be looked out for, in this piece of tropical railway engineering work, is the avoidance of low, bottom-land river crossings, where flood elevations are so uncertain and difficult to determine. It is a noteworthy characteristic of the Amazon tributaries that at their confluence with other branches the alluvial deposits and mires which form the shore line are extremely low, treacherous, and during the flood seasons completely inundated to a considerable depth for miles back from the junction, making the crossing of these feeder streams at their mouths, by following the course of the main stream, decidedly dangerous and costly if not altogether impossible. It is probable that a line 40 miles back from the present proposed route, along the southeast bank of the Madeira, would fall on higher and much more available ground; while the stream crossings, though perhaps more numerous, would probably be found to be decidedly narrower and safer and very much cheaper to bridge, if economy in this item were sought. Such a line would, furthermore, be about 60 miles shorter than the river course.

Further description of the proposed route is impossible, if indeed any definite route were proposed. It must be borne in mind that the territory through which any presumably feasible lines may pass is, without question, the most

*Fort Lee, N. J.

†A book recording the experiences of the Collins expedition has just been published by J. B. Lippincott & Co. See Eng. News, Oct. 17, p. 426.—Ed.

unexplored and absolutely unknown region in the world. No exploring foot, perhaps not even that of the native savage, so far as observations indicate, has ever trodden the soil of that desolate, pathless, almost impenetrable jungle. These thousands of square miles of forest are broken by no highway other than the extensive network of rivers and streams flowing into the great yellow Amazon.

Gazing from the deck of a river steamer into the maze of giant trees, of peculiarly tropical shapes and colors, chained together by a jungle of massive leafless cables growing up out of a still more dense mass of brilliant, spiny, interlaced and almost uncut-able aromatic underbrush, the eye reaches at best a few hundred feet into the wilderness. What may lie beyond is altogether a matter of conjecture: more jungle, no doubt, stretching away for miles over this monotonously low, level plain of silt; but is it all the same rank verdure, growing up out of a chain of black, stagnant, lake-like swamps, strung together by shallow creeks and streams, as it would appear from a short trip inland? Careful exploration may disclose the existence of an elevated jungleless plateau, or the rolling foot-hills of some undiscovered ridge, such as it is reported by a few wandering Indians there exists, "many days' journey back from the water's edge." Such maps and plans of this territory as are in use, even to the geographical charting of the extensive network of streams—dozens of which have never been seen by white men—are based on extremely crude records and observations made by different unofficial parties of adventurers and semi-explorers, engaged principally in seeking the chimerical Eldorado of the tropics. Subsequent stellar observations and meridional determinations have proven these records to be quite incorrect in many essentials.

In order to convey a clearer idea of the problem which confronts the concessionaires for this railway, it is necessary to direct attention to the inaccessibility of the location except by river boats from Para, which operate in the flood seasons of the year.

Santo Antonio do Madeira, the headquarters station and initial point of beginning of the extensive exploration and reconnoissance surveys which must be made before any sensible plan for the future conduct of the work can be formulated, is little more than an Indian village, numbering perhaps 300 inhabitants and buried over 1,700 miles distant within the forest from the port of Para at the mouth of the Amazon. The town derives its importance from the fact that, situated on the edge of a deep broad basin at the foot of the first rapids, which impede further navigation and separate Bolivia from Brazil, it receives all the transit cargo destined for Bolivia, as well as that which is forwarded from that country for export.

The river steamers tie up along the precipitous banks of a small point of land, rising to a summit some 50 ft. in height and jutting out into the stream perhaps 300 ft.; upon this the town is located. Perhaps a dozen typically tropical plastered adobe residences line the main street, while three or four long, low warehouses and storage sheds covered with corrugated iron, and a few "tiendas" and "cantinas," complete the list of buildings. Native bamboo and palm leaf huts dot what remains of the small clearing.

The largest and best of these residences is occupied by the manager of the shipping and receiving depot here established and controlled by the members of Suarez & Co. (an association of wealthy Bolivian merchants, "haciendados" and rubber exporters), who is also the Bolivian Consular Agent at that transfer point; from this depot cargoes are taken in small, canoe-load lots and transported by a very tedious, dangerous and costly system of rapid-stemming and portages to the upper navigable sections of the river.

The remaining buildings are utilized by the staff of assistants and clerks and other native employees and their households; these included in all, on the arrival of the expedition, only five white men—an Englishman, three Germans and a Portuguese. Half the residence occupied by the Consul was immediately procured by the Assistant Chief Engineer through the courtesy of that gentleman, and converted into a headquarters office and private quarters; while the officers of Suarez & Co. extended to the expedition numerous facilities for the immediate storage of supplies and material, for which no provision had been made. With this exception, the party upon its arrival prepared to go into encampment.

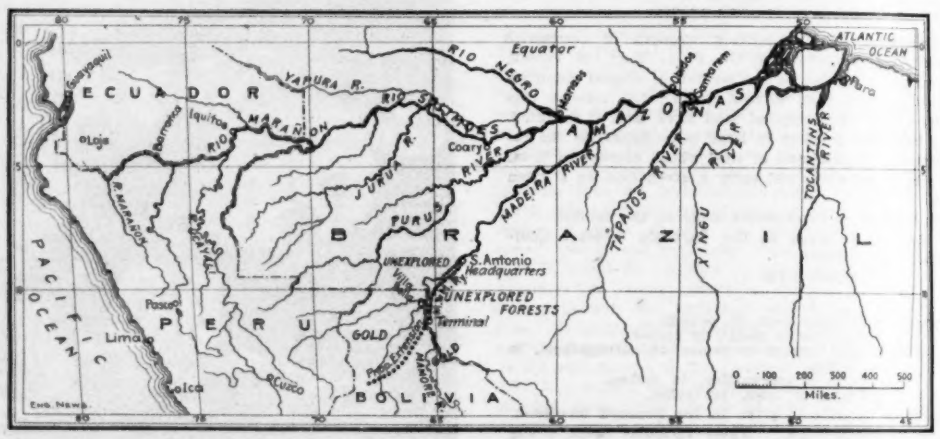
The trip from Para to San Antonio is made by the river steamers of the Amazon Steam Navigation Company's service, about once monthly, and consumes on an average about 15 days' sailing. It must be remembered in this connection that the current of the Amazon varies between 4 and 6 miles per hour, that the vessels make frequent stops along the sheer banks of the river, in order to take aboard their cargoes of rubber nuts, hides and dye-woods from some 260 depositories along the route, and that the navigation of the upper and imperfectly charted reaches of river is decidedly dangerous and is often discontinued after nightfall. Twenty days are thus often consumed in making the trip; while in the dry seasons, when the stream falls as much as 80 ft. in elevation, the steam navigation of the Madeira River is discontinued for several months.

The distance from New York to Para, 3,100 miles, is traversed by the type of vessel plying between these ports in about 14 days. Connections between the ocean and river steamers are rarely made within less time than one week, which makes it safe to state that the field operations are being conducted more than 4,700 miles removed from the general offices of the company at New York, and that the shortest duration of a trip between them is at least 35 days. These facts present quite a definite idea of the remoteness of the one established point in the project.

Consider further that there are mails but once monthly, unless carried by some special steamer on a short trip from Manaos; that there are no means of telegraphic communication with the nearest cable station, Manaos, over 700 miles down the river; that the shortest emergency time to Manaos by canoe is 10 days, and that no medical assistance or supplies of any kind could reach San Antonio from any where within 30 days after notice had been sent; that there is no native labor—not even a few Indians to serve as guides, clearing gangs or pack carriers—within 1,000 and often 2,000 miles; no natural resources in the shape of lumber, grain, live-stock, fruit, game or food-stuffs of any description; no grazing or farm lands which could be stocked or put under cultivation within less time than one year; no adequate nor clean water supply; no hills nor other healthful elevations within 800 miles to which fever victims could be rushed in an emergency; no means of purchasing or obtaining the commonest necessities of life; no adequate buildings, quarters, or natural camp sites; nothing, absolutely nothing, within hundreds of miles and many days' travel, but jungle, swamp and wilderness, unless it is the number of insect pests which infest the forests. Could any spot on earth be more completely isolated?

Here indeed, if ever, was the need presented for a thorough preliminary investigation, under the direction of a thoroughly capable engineer of mature judgment and skill and broad tropical experience. A small party, consisting of one or two assistant engineers, a competent physician with experience in tropical railway work or the sanitation of tropical army corps, and an experienced, thoroughly practical construction superintendent with an eye to the utilization of such natural advantages as may have presented themselves by a careful study of the ground, might have accompanied the inspecting engineer to assist in collecting all the necessary information, details and data for a complete and reliable report on which could have been based with some degree of accuracy a systematic estimate and specifications for material, equipment and medical supplies to accompany the first working party into the field.

Unfortunately, certain limitations under which the construction company seems to have been laboring made such a preliminary investigation inconvenient, and it is therefore a matter of record that no one connected with the enterprise had ever been within a thousand miles of San Antonio. It can readily be conjectured, therefore, how meager must have been the knowledge of conditions on which were based such preparations as were made.




OUTLINE MAP OF PART OF SOUTH AMERICA, SHOWING GENERAL LOCATION OF MADEIRA & MAMORE R. R.

(Drawn from a map compiled by the Amazon Steam Navigation Co., Ltd.)

The contractors' principal assistant arrived in New York from London about 15 days prior to the sailing of the expedition and, in his official capacity of Assistant Chief Engineer of the Madeira-Mamore Railway, proceeded to organize the engineering parties and secure the equipment and supplies which accompanied them or were left for future shipment by the company's purchasing agent—as Mr. Miller accompanied the expedition. On the afternoon of May 6, 1907, the Assistant Chief Engineer and his staff of 12 assistant engineers, one physician and one cook, sailed from New York on the S. S. "Grangense" of the Booth line. Five or six additional assistant engineers, a cook, several other minor assistants and several tons of supplies were left to follow by the next boat.

On May 14 the party arrived at Barbados en route, and on Monday, May 20, Para was reached, 14 days from New York.

At Para unforeseen difficulties at once arose concerning the entrance of some 20 tons of material and supplies, without payment of the regular custom tariff. This privilege had been granted the concessionaires by the Government of Brazil. A long delay ensued, which fortunately, however, was turned to profitable account in that the engineering staff of the railway was temporarily placed at the disposition of the Engineering Department of the Para Port Works, then engaged in executing the plans for an extensive harbor improvement scheme. Two divisions were organized and placed in charge

of two chiefs of party, and an acceptable hydrographic survey of the harbor was completed before the expedition again embarked.

Meanwhile Mr. May had arrived from New York with some 15 men, including four engineers, and finding it impossible to compel the observance of the company's privileges without formal appeal to the Federal authorities, he paid the duties on the cargo to obviate further costly delays, and the expedition sailed on a specially chartered steamer—the "Javary"—June 9, 1907, after 10 days' delay.

It was learned shortly before the departure from Para that a party of construction foremen, under the direction of a Superintendent of Construction, had been detailed by Mr. May to accompany the expedition party to San Antonio for the purpose of generally supervising the construction and arrangement of the engineering headquarters camp. These men were brought from New York by Mr. May. A gang of laborers consisting of 100 men was also organized at Para, provisions for three months were purchased, and the motley crowd embarked on the lower deck, along with the cattle, hogs, sheep and poultry, as third-class passengers. The expedition, now numbering about 140 officers and men, with several tons of additional supplies, was then finally ready to depart.

Once under way, everything settled down to normal conditions; and while the Principal Assistant Engineer devoted his time to planning out the most suitable subdivision of the work, parties and laborers, as well as the repacking of material and provisions into convenient 50 and 100-lb. parcels for handling at the portages, the balance of the party loiled about the deck of their "private yacht" enjoying a splendid view of the mysterious Amazon. The trip was intensely interesting and instructive every mile of the long way, and nothing of moment occurred until the arrival at Manaos. The Superintendent of Construction, an old-time, faithful powder man and walking boss in the employ of the May-Jeckyll Company during their subcontracting days, had assumed charge of the practical work of the expedition, and matters were running smoothly when he discovered that some 40 men had "jumped the outfit" at Manaos. Further investigation disclosed that these men had "shipped with the gang" merely to evade the payment of their passage to Manaos, where work in the rubber camps at 7 milreis ($2.30) per day awaited them. In the service of the company these men received 4 milreis ($1.30).

Immediately upon the arrival at San Antonio some 20 additional men left the company gang and found much more remunerative employment with the transportation and freight canoe outfits on the river, while the 40 odd remaining laborers were hastily divided into several clearing and camp constructing forces or used in unloading and storing the cargo. However, gradually but steadily the men slipped off into the rubber camps which operate along the shore and perhaps a mile or two back in the forests, and the available forces for exploration work and reconnoissance surveys continually decreased, until on the first of July, 1907, there were but 28 men left—not enough to cut out the preliminary line of survey for the first ten kilometers, which the company were under obligations to locate and submit plans of to the Government Inspector within one month from that date. How any such agreement could have been entered into by an experienced engineer, with a broad knowledge of the difficulties which must be overcome in initiating tropical work of such magnitude, is a complete mystery to the writer.

Conflict of authority arose at this point. The Superintendent wanted every available man for necessary camp construction, while imperative orders were issued daily by the Chief, Mr. Miller, to his principal assistant and the chiefs of the two preliminary parties to rush the location of the first ten kilometers. Engineering work had been commenced and the first stake driven within three days after the arrival, on June 23. That no adequate preparations for quartering the officers and men could have been made in this short time is self-evident.

Scarcity of equipment and supplies essential to the comfort and health of the organization made itself felt within a few days after operations were begun. Insect pests; the intense heat during the day; the damp, chilly nights; the poisonous condition of the drinking water; the stenches arising from swamp-holes and hastily constructed privy-pits; the congesting effect of wet nights under loosely erected shacks or "baracas," sideless and covered with a few spare tarpaulins, where the men slept without beds, bedding or blankets; the lack of proper and nourishing food and the general lack of equipment—all these combined to sap the health and spirits of the organization.

Finally, on June 28, a general protest was drawn up against the intolerable conditions and dangerous neglect of sanitary improvements, together with a request that the field work be suspended at once until necessary arrangements for dry, clean quarters, at least, could be made, and submitted to the Chief Engineer at his headquarters in town. The petition, numbering in total 11 distinct requests, was verbally acceded to, and the work was partially continued at the urgent request of the Chief. A party was detailed to improve the camp site as much as the limitations would permit.

The burden of insufficient preparation was greater, however, than the organization could bear in their effort to do efficient work. Laborers continued to leave at the rate or four or five per day. Sickness and general physical disability, due to the continuous strain without proper rest, food or care, broke down the efficiency of the party.

Dissatisfaction among the members of the engineering corps, which had already been manifested during the stay at Para, increased to the point of open rupture. This is not the place to record the details of personal disagreement or controversies, and the writer merely records that on July 6, the Principal Assistant Engineer, the Chiefs of the two field parties and a 2d Asst. Engineer left San Antonio and set out for Manaos, whence they proceeded to the United States. On the day of their departure, 3 of the remaining 11 members of the engineering staff were down with fever, while no hospital had been provided. Of the 60 laborers who arrived at San Antonio, but 19 remained, of which number 5 were seriously ill. On Friday, July 19, the returning party of four engineers, then delayed at Manaos, received word from the captain of a special steamer, which they had passed on their way down the river, and which on that day returned from San Antonio, that of 16 laborers in camp 9 were critically ill and without proper medical attendance, and that two had died. Of the engineers, five men were down with fever, including the Chief; and of the 10 men forming the contractors' camp 3 men were seriously ill. Work had been suspended entirely.

On Sept. 2 four pitiful letters from two still-active members of the party reached New York. The latest of these is in part as follows:

> Work has not been resumed as all but three or four men are either very ill or in such physical condition as to unfit them entirely for work. Mr. Miller is dangerously ill, the doctor being continually in attendance. At two o'clock this morning (July 29) Villanova died of fever after an illness of ten days.
>
> There are no more laborers except a dozen or more poor, sick devils who will die as the others have. We have eleven sick men piled into one tent standing in the hot sun. It is terrible. The Superintendent of Construction has gone to Manaos for help and we have heard that two or three of the men there are very low. Some of the boys are keeping up courage but they all look very bad.

The writer has no interest nor desire in recording these facts, other than to set before the profession an object lesson of the absolute necessity of putting sanitation ahead of every other consideration in carrying out an engineering work in the tropics. And of all places in the world the Amazon valley is the place where this is most essential. The history of the work at Panama, under American management, where the sanitary squad preceded the engineer and constructor, must be copied by those who are undertaking work in the far more deadly Amazon swamps, if they expect to achieve success and not the fatal failure that befell their predecessors, the unfortunate Collins expedition.

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Before printing the above article we submitted proofs of it to the Madeira & Mamore R. R. Co., whose New York offices are at 80 Broadway, giving them an opportunity to make reply, if they so desired, in the same issue. They found it necessary to forward the proofs to their London headquarters. We are in receipt of a cablegram from Mr. E. L. Corthell, who we understand is acting as engineering adviser to the company, reading as follows:

London, Oct. 15.

I have read proof of article on the Madeira & Mamore Ry. The criticisms are unjust and the letter inserted near the end of the article exaggerates conditions. The company is building headquarters, storehouses and hospital and furnishing refrigerating plant. The sanitary arrangements are suitable and there are plenty of provisions. I have late reliable information from San Antonio.

We may also say, after careful reading of Mr. Craig's book (reviewed on page 426 of our last issue) that there is somewhat more information available as to the country through which this proposed railway is to run than the writer of the above article was probably aware. The engineers of the Collins expedition in 1878 surveyed no less than 320 miles of lines through the forest and completed the location of the railway line for 67 miles. Of this, 36 miles was staked out on the ground and accepted by the railway company. Grading was completed or put under way for a distance of 7 miles and track was laid and construction trains run for nearly 4 miles. Therefore, the final location of the first 10 kilometers within a very short time from starting work at the present day was not so unreasonable a task as might at first appear.

As for the living conditions at San Antonio, Mr. Craig states that thirty years ago, when the Americans reached there, a proverb was current that "San Antonio was the place where the devil left his boots." No one will pretend that the place is a sanitary resort at the present day or that life there under any condition can be made a picnic. Undoubtedly workers ought to be protected by all the means which recent researches in tropical sanitation have made possible; and we hope to be able to present in a later issue, fuller information as to the extent to which this is being done.—Ed. Eng. News.

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EXPLOSION OF THE GAS PLANT at New Hartford, Conn., on Oct. 19, is reported to have killed two persons and injured a number of others.

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A MINE CAVE-IN was reported from Newcastle, New South Wales, on Oct. 18. The residential quarter of Newcastle is under-cut by old mine workings, which gave way. No casualties were reported, but the estimated property damage was $500,000. Newcastle is a town of about 60,000 inhabitants.

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A CAVE-IN OCCURRED on Oct. 17 in the tunnel of the New York & New Jersey R. R. Co., at Sixth Ave. and 32d St., New York City. A 2-ton mass of earth, loosened by the excavation, fell and caught six men beneath it. A panic followed and the remainder of the 20 workmen refused to dig out the buried six. They were finally rescued alive, though four were seriously injured.

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A PECULIAR BRIDGE ACCIDENT was reported from Chicago, on Oct. 18. The front car of a Metropolitan "L" train ran up on the opening lift of a bascule bridge between Jackson Boulevard and Van Buren St., the bridge being elevated to an angle of nearly 45°. The power shut off, the car fell back down the incline and telescoped with the second car. Eight persons were in the car, but all escaped without serious injury.

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EXCEPTIONALLY SEVERE STORMS were reported from Southern Europe on Oct. 16. A heavy gale swept the coasts of France, Spain and Portugal and, coming so soon after the recent unprecedented rain-falls and floods in those countries, has caused much distress and property loss.

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SPAIN REPORTS A RAILWAY WRECK of some magnitude for the list of the past week. Twenty-seven persons were reported killed or wounded in a wreck on Oct. 18 at Orio, at the mouth of the Orio River on the Bay of Biscay. This wreck adds one more to the exceptional number that have been reported from Europe during the past month.

At Rudd, N. C., on Oct. 18, a passenger train on the Southern Ry. collided with a freight train at night. Three persons were killed and 37 injured. The freight train was side-tracked at Rudd and the switch to the main line was left open, it is said, by a careless flagman.

The "California Limited" east-bound train on the Atchison, Topeka & Santa Fe Ry. went into the ditch at Earl, Colo., on Oct. 18, while traveling at high speed. The engineer was killed, the fireman fatally injured and a number of passengers seriously injured. Press reports state that the company refuses all details.

One person was killed and 20 injured at the Wells St. station (Chicago) of the Chicago & Northwestern Ry. on Oct. 19. Two suburban trains collided head-on within the yards; misunderstanding of signals, between the engineer and the tower man, caused the collision.

FIVE SERIOUS ELECTRIC RAILWAY WRECKS have been reported this week. At Erie, Pa., a passenger car on the line of the Buffalo & Lake Erie Traction Co. ran into a switch and collided with a work car on Oct. 14. Twenty-five persons were injured, the majority seriously but none fatally. The switch is reported not to have been properly locked.

At Cincinnati, on Oct. 16, an Elberon Ave. car left the track and rolled over a 25-ft. embankment at Mount Hope. The car landed upside down and the trucks crashed through the flooring; one man was killed and 30 persons injured, some of them fatally. Loss of control of the car on a steep grade is the reported cause of the wreck.

Another bad wreck is also reported from Cincinnati, on Oct. 21. A Cincinnati, Hamilton & Dayton train struck a John St. car at the Harrison Ave. crossing—known as "dead man's crossing." One person—a woman—was killed, and six injured. Misunderstanding of signals at the crossing is reported as the cause of the collision.

At Chattanooga, on Oct. 18, four persons were killed, 10 seriously injured and more than 20 suffered minor injuries in a head-on collision between two electric cars on Harrison Ave. Both motormen were instantly killed. The accident is said to have been preceded by a break of some kind at the power-house, and the current was off. A third car, just behind the incoming car, missed a second collision by only three feet, a heavy fog obscuring the tracks. A confusion is reported in the electric signals, which allowed three cars in the same block at the same time.

The Ohio interurban lines, according to press report, are again contributors to the death list. On Oct. 20 two cars on the Cleveland, Akron & Bedford line collided head-on near Cuyahoga Falls. The motorman is reported killed, and 19 persons injured.

WIRELESS TELEGRAPH SERVICE was commercially instituted across the Atlantic on Thursday, Oct. 17 by the Marconi Wireless Telegraph Company. It is reported that about 13,000 words were transmitted from the American station at Glace Bay, Cape Breton, Nova Scotia, and about 2,000 were received from the European station at Clifden, Ireland. The first messages were congratulatory and press exchanges. It is expected that press and public service will be in regular operation shortly. The rates will be ten cents per word for private messages and five cents for press dispatches. Press dispatches will be accepted only for papers with which contracts have been made. Messages for over-sea transmission by the Marconi Company are filed as usual at the Western Union or Postal offices. These companies transmit to Glace Bay and deliver the message to the Marconi Company. According to press dispatches, a terrific gale on Oct. 21 cut off the telegraphic communication of Cape Breton with the mainland, while messages to the American continent were sent by the wireless service to Clifden, Ireland, and thence cabled back.

A TUNNEL 6.04 MILES LONG through the continental divide of the Rocky Mountains is to be built about 50 miles west of Denver, Colo., and near James Peak, south of the line of the Denver, Northwestern & Pacific Ry. The Continental Tunnel Co. has been incorporated to build the tunnel; the railway company will guarantee the interest on the bonds issued for construction and will retire the bonds when due, thus becoming the owner of the tunnel. The authorized bond issue is $5,000,000. The tunnel will be 6.04 miles in length, on a tangent throughout, and with ascending grades of 0.25% from the east end and 0.70% from the west end. The elevations above sea level will be 9,229 ft. at the apex of the grades, 9,190 ft. at the east portal and 9,100 ft. at the west portal. The tunnel will eliminate 3.3 miles of 2% grade and 28.3 miles of 4% grade now on the temporary line of this new railway constructed over the main range at the Corona Pass, which is at an elevation of 11,660 ft. It will save 22.6 mi. in distance and 2,431 ft. of elevation. It is expected that construction will be commenced before December, and that the tunnel will be built in three or four years with the most modern and improved systems of handling work of this kind. Mr. Thomas F. Walsh is President of the tunnel company; and Mr. Herbert George is General Manager. The Chief Engineer is Mr. H. A. Sumner, who is also Chief Engineer of the Denver, Northwestern & Pacific Ry.

## PERSONALS.

Mr. B. W. Hicks has been appointed Chief Engineer of the Wisconsin & Michigan Ry., with headquarters at Peshtigo, Wis.

Mr. J. H. Nash has been appointed Master Mechanic of the Illinois Central R. R., at Paducah, Ky., succeeding Mr. R. E. Fulmer, resigned.

Col. Joseph L. Wickes, who was appointed Commissioner of Street Cleaning of Baltimore four years ago by the late Mayor McLane, has been reappointed.

Mr. W. W. Sisson has been elected to the vacancy on the Board of Water Commissioners of Binghamton, N. Y., caused by the death of B. S. Curran on Oct. 3.

Mr. Harry J. Horn, General Manager of the Northern Pacific Ry., has resigned. Mr. Geo. T. Slade, son-in-law of J. J. Hill, has been appointed as his successor.

Mr. Henry E. Cooper has been elected a director of the Albany & Susquehanna R. R. (D. & H. System) to fill the vacancy left by the death of John Harsen Rhoades.

Col. Rollin H. Wilbur has been elected Vice-President and General Manager of the Lehigh & New England R. R.—one of the railroad properties of the Lehigh Coal & Navigation Co.

Capt. Horton W. Stickle, Corps of Engineers, U. S. A., has been ordered to Culebra, Canal Zone, for duty in connection with the construction of the Gatun locks. He has been at West Point as Assistant to the Officer in Charge of Construction.

Mr. Emmet D. Boyle, M. Am. Inst. M. E., has opened an office in the Clay-Peters Building, Reno, Nev., as a consulting mining engineer. Mr. Boyle was formerly Superintendent of the North Rapidan Gold & Silver Mining Co., at Dayton, Nev.

The retirement next month of Col. Garrett J. Lydecker, Corps of Engineers, U. S. A., will promote Lieut.-Col. Jos. H. Willard, Maj. Jas. G. Warren, Capt. Jas. F. McIndoe, First Lieut. Wm. P. Stokey and Second Lieut. Wm. F. Endress.

Messrs. G. C. Noble, Assoc. Am. Inst. E. E., formerly of the faculty of the University of California, and Chas. S. Davidson, have opened offices in the Crocker Building, San Francisco, as Consulting Engineers in electrical and hydraulic engineering and power development.

Mr. Samuel Merrill Gray, M. Am. Soc. C. E., a consulting engineer of Providence, R. I., and formerly City Engineer of Providence, has been appointed one of the appraisers of the water plant at Denver. The plant is to be acquired by the city from private ownership, and a board of appraisers has been appointed to assess its valuation.

Mr. Wm. Frank Hall, for seven years identified with the Bradley Pulverizer Co., makers of the Griffin mill—well known to cement men—has resigned to accept a similar position with the Lehigh Car, Wheel & Axle Works in the sales of their Fuller-Lehigh pulverizing mill. Mr. Hall will open a new office for the latter company at 111 Broadway, New York City.

Mr. F. E. Ward, General Manager of the Great Northern Ry., has tendered his resignation to take effect on Nov. 1. He will become associated with the Chicago, Burlington & Quincy Ry. Co. Mr. J. N. Gruber, General Manager of the Burlington lines east of the Missouri River and formerly with the Great Northern as a division superintendent, is to return to the Great Northern.

Mr. C. F. Muralt, M. Am. Inst. E. E., of the firm of Muralt & Co., Consulting Engineers, 114 Liberty St., New York City, has been appointed to fill the newly created Chair of Applied Electrical Engineering at the University of Michigan. He will continue in active practice, as the Board of Regents desires that the instructor in that department be in close touch with the advances in the field of applied electricity.

Rear-Admiral Geo. W. Melville, Engineer-in-Chief, U. S. N. (retired), Past President of the American Society of Mechanical Engineers, was married on Oct. 17 to Miss Estella S. Polis, of Philadelphia, in the "Little Church Around the Corner," New York City. Since Admiral Melville's retirement, in 1903, he has been a member of the firm of Melville & Macalpine, Consulting Engineers and Naval Architects, of Philadelphia.

Mr. J. Vipond Davies, M. Am. Soc. C. E., of the firm of Jacobs & Davies, Consulting Engineers, New York City, was painfully injured on Oct. 17 while attempting to stop a runaway team at the station of the Long Island R. R., Long Island City. The team dragged Mr. Davies and threw him against a tree, inflicting a bad scalp wound and severely bruising him about the limbs. He is reported as progressing well towards recovery.

Mr. F. H. Newell, Director of the U. S. Reclamation Service, has just returned to Washington from an inspection trip which began about the first of May. He has visited many of the Reclamation projects of the West, and has accompanied Secretary Garfield on his trip to nine of the most important of the projects. During the last three weeks he was with the Inland Waterways Commission, of which he is a member, and with which Commission inspected the condition of navigation on the Great Lakes and on the Mississippi River and tributaries.

Mr. David B. Carse, M. Am. Soc. M. E., has resigned from the chairmanship of the Advisory Committee of the U. S. Steel Corporation; since the organization of the committee five years ago, Mr. Carse and his brother, John B. Carse, have composed its personnel; the duties of the committee have been to keep track of all expenditures of the Corporation under the appropriations by the Finance Committee. Mr. Carse is well known to American railway men, as previous to his appointment by the Steel Corporation he was President of the Carse Brothers Co., makers of railway and car-work machinery; he is an authority on the arrangement, equipment and operation of railway, machine and car shops, and was Resident Engineer in charge of construction of the Hegewisch Works—now known as the Burnham Works—of the Pressed Steel Car Co. In leaving his present work, he returns to the business of the Carse Brothers Co., as its President. In the reorganization of the company its headquarters have been removed from Chicago to 12 Broadway, New York City. Mr. John B. Carse will probably become Chairman of the Advisory Committee of the Steel Corporation.

### Obituary.

Geo. Frederick Bodley, the famous English architect, is dead, according to cable dispatches of Oct. 21.

Maurice Loewy, the distinguished French astronomer, Director of the Paris Observatory, dropped dead in Paris on Oct. 15 while attending a meeting of the National Board of French Observatories. He was born in Vienna in 1832.

Jesse Holladay, a brother of the late Benjamin Holladay, and once associated with the latter in the famous "pony express"—for many years the only means of carrying the mails across the western plains—died in Chicago on Oct. 15. He was born in Kentucky in 1825, and went to California in 1850. With his brother he owned a steamship line operating between San Francisco and Honolulu.

Thomas Hilton Williams, Sr., M. Am. Soc. M. E., President and General Manager of the A. A. Griffin Iron Co., and President of the E. A. Williams Co., brass founders, Jersey City, N. J., died at his home in Jersey City on Oct. 19 at the age of 59. Mr. Williams was also a member of the Engineers' and Lawyers' Clubs, of New York City, and the Carteret Club, Jersey City; he was also associated with the American Geographical Society, of Washington.

## ENGINEERING SOCIETIES.

### COMING MEETINGS.

**AMERICAN PEAT ASSOCIATION.**
Oct. 23-26. Convention for organization at Jamestown Exposition. Address Julius Bordollo, Kingsbridge, New York City.

**ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION.**
Nov. 11-14. Twenty-fifth annual convention at Chicago. Secy., W. E. Emery, C. & A. Ry., Kansas City, Mo.

**AMERICAN MINING CONGRESS.**
Nov. 11-16. Tenth annual convention at Joplin, Mo. Secy., J. F. Calbreath, Jr., Denver.

**AMERICAN CIVIC ASSOCIATION.**
**NATIONAL MUNICIPAL LEAGUE.**
Nov. 19-21. Joint convention at Providence, R. I. Secy., Clinton R. Woodruff, North American Building, Philadelphia.

**SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.**
Nov. 22-23. Annual meeting at New York City. Secy., W. J. Baxter, 29 West 39th St., New York City.

**SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.**
Dec. 5-7. Convention at Chicago. Secy., C. R. Richards, Columbia University, New York City.

ILLUMINATING ENGINEERING SOCIETY.—A paper, entitled "Fixture Design from the Standpoint of an Illuminating Engineer," by V. R. Lansingh and C. W. Heck, was read before the Philadelphia section on Friday, Oct. 18, and before the New York section on Monday, Oct. 21. The latter meeting was held at the Engineering Societies' Building, 29 West 39th St., New York City.

The design of illuminating fixtures was considered with three considerations always in view: (1) Elimination of bright sources in the field of vision; (2) artistic treatment and definite motive of design; (3) economy and good illumination. The field of fixture design was divided into two classes; one dealing with bracket and ceiling fittings, the second with chandeliers and portables. The first division alone was treated in the paper presented and the second was left for a future discussion.

The faults of some present types of fixtures were shown with suggestions for improvement along the three lines mentioned before.

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